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CORRECTIONS

NSA Vol. 18, No. 3, p. 582. In abstract 4366, report number NP-13325 should be NP-13352.

NSA Vol. 18, No. 6, p. 1311. In abstract 9792, journal reference Z. Physik. should be Z. Physik. Chem.

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Volume 18, Number 8 April 30, 1964

NUCLEAR SCIENCE ABSTRACTS

BIOLOGY AND MEDICINE

General

11557 (AD-412416) ABSORPTION OF RADIOACTIVE IODINE (NaI^{131}) AND STRONTIUM ($Sr^{85}(NO_3)_2$) THROUGH NORMAL SKIN, FIRST, SECOND, THIRD DEGREE BURNS AND OPEN TRAUMATIC WOUNDS. Annual Progress Report, June 1, 1962–May 31, 1963 (Complementing the Semi-Annual Report, June 1, 1962–December 1, 1962). John M. Howard and W. William Salak (Hahnemann Medical Coll. and Hospital, Philadelphia). Contract DA-49-007-MD-991. 41p.

No penetration of I^{131} or Sr^{85} across normal, intact skin was demonstrated. Variable amounts of I^{131} were absorbed through first degree burns on different days of the first week, depending upon associated trauma and ulcerations. Considerably larger amounts of I^{131} and Sr^{85} were absorbed through fresh second degree burns. The absorption decreased with the healing of the burn. Third degree burns followed a similar pattern of absorption as second with lesser quantities absorbed. Penetration of I^{131} and Sr^{85} across open traumatic wounds showed initially a lower amount in fresh bleeding wounds with the highest quantities being absorbed in one-day-old wounds. Thereafter there was a decrease in absorption. Granulation tissues permitted the passage of relatively constant amounts of ions. Among plain bandage, Furacin and petrolatum ointments, Rezifilm plastic spray, and vaseline gauze, used as protective dressings to prevent the absorption of radioactive fallout, vaseline gauze was found to be the most effective. Studies included the absorption of bacterial toxins and antibiotics across the wound surface. (auth)

11558 (NP-13555) QUARTERLY PROGRESS REPORT NO. 50 [ON RADIOBIOLOGY]. (Chicago. Univ. Air Force Radiation Lab.). Jan. 15, 1964. Contract AF41(609)-1693. 132p.

Separate abstracts were prepared for 9 sections of this report. (C.H.)

For abstracts of individual sections see: 11570, 11630, 11631, 11632, 11843, 11844, 11845, 11846, and 11847.

11559 (TID-19977) FISSION PRODUCT METABOLISM AND RESPONSE IN LABORATORY AND DOMESTIC ANIMALS. Progress Report, April 1, 1958–January 31, 1964. C. L. Comar, F. W. Lengemann, R. H. Wasserman, et al. (New York. State Univ. Veterinary Coll., Ithaca). Contract AT(30-1)-2147. 147p.

Research activities during the past 6 years are reviewed. Results are reported for recent studies on adaptation to increased dietary Ca by dairy cows as a factor in the reduction of Sr^{90} content of milk; the testing of a theoretical model of alkaline earth absorption in rats by a comparison of biological discrimination among Ca^{47}, Sr^{85}, and Ba^{133} in the presence of glucose, lactose, and lysine; the effects of lactose on the intestinal absorption of Ca in rats; a comparison of the ileal absorption of Ca^{47} and Sr^{85} by rats from solutions with high and low concentrations of stable Ca; determinations of the Ca, Mg, and total alkaline earth content in mucosal tissue and plasma of normally fed rats, fasted rats, and rats fed a lactose solution; an investigation of non-exchangeable Ca compartments in the plasma of sheep; the effect of lactose and vitamin D on calcification in the rachitic chick; the metabolism and milk content of I^{131} of dairy cows after long-term daily administration of I^{131}; the absorption of Fe^{59} in sheep; the development of a method for the estimation of parasitic blood loss in sheep by whole-body counting of Fe^{59} retention; the development of a method for the simultaneous measurement of erythrocyte and plasma volume in sheep using Fe^{59} as a tracer; the concentration of Na^{22}, Cl^{36}, and C^{14}-inulin in rat kidney and counter-current mechanisms for the production of concentrated urine in mammals; the effects of diuretics on the distribution of Na^{22}, Fe^{59}-labeled erythrocytes, and I^{131}-labeled albumin in rat kidneys; the effects of thiamine on nervous response to ultraviolet radiation in frogs and lobsters; the effects of γ radiation on reproductive capabilities of young male rabbits; and an evaluation of the contamination of the food chain by fallout fission products, with emphasis on Sr^{90}, Cs^{137}, and I^{131} intake from total diet and individual food items. A list is included of publications resulting from research conducted under this contract. (C.H.)

11560 (UCLA-520) SEMIANNUAL PROGRESS REPORT FOR THE PERIOD ENDING DECEMBER 31, 1963. (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). Contract AT(04-1)-Gen-12. 96p.

Separate abstracts were prepared on 6 sections of this report. (C.H.)

For abstracts of individual sections see: 11561, 11569, 11574, 11653, 11848, and 12466.

11561 (UCLA-520(p.43-51)) PHARMACOLOGY AND TOXICOLOGY. (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology).

An evaluation of the usefulness of the kangaroo rat as an experimental laboratory animal showed that this animal is readily trained and can exist on a dried diet with

only a bare minimum of water obtained from succulent plants. Data are included from preliminary blood and psychological studies on the kangaroo rat. (C.H.)

11562 THE BEHAVIOR OF RADIOIODINE ACTIVITY IN THE BLOOD AND IN ANIMAL ORGANS UNDER THE INFLUENCE OF L-CARNITINE. W. Rotzsch and H. Willgerodt (Karl Marx Universität, Leipzig). Acta Biol. Med. Ger., 9: 632-40(1962). (In German)

Previous experiments showed a partially antagonistic influence of carnitine on thyroid hormones. Carnitine lowers the elevated basal metabolic rate in hyperthyroidism, brings the vitamin B concentrations (increased by thyroxin in the skeletal muscles) into physiologic range, and influences protein metabolism which is altered by thyroid hormones. To elucidate this effect, the body distribution of I^{131} was investigated after introducing carnitine. The hormonal protein-bound iodine in serum, electrophoretically determined, indicated significant quantitative differences in mice and rats after carnitine treatment, pointing to a basic difference in iodine metabolism. Albino mice (body wt 20 g) and Fisher strain rats were injected intraperitoneally with L-carnitine in the form of free betaine (animals in the control group received 0.9% NaCl solution). Carrier-free NaI^{131} was given in doses of 0.05 to 10.0 μC/g. The total iodine activity of the blood, liver, and muscle was found to be the same in the experimental as in the control group. The activity curves for both blood and muscle of mice showed essentially the same characteristics. The amount of iodine increased for the first 30 min, then decreased. After 24 hr it increased again, owing to the release of iodine-labeled hormones from the thyroid gland. The specific activity of rat serum showed similar characteristics to that of mice serum, except that the 24-hr value was higher. This observation was the subject of further experiments. The specific activity of the filtrate of rat serum taken at 24 hr notably increased, while the amount of iodine absorbed by the asbestos filter decreased as compared with the findings on mouse serum. A marked difference was found in the total activity of blood in rats and mice. Electrophoretic separation of serum proteins using 0.01 to 0.02 ml serum showed that most of the iodine in mouse serum was already protein bound after 20 hr. The distribution of the I^{131}-labeled hormones among the serum protein was electrophoretically determined in paper strips. The activity curves obtained from radioelectropherograms of serum show the height of curves for mice to be about $\frac{1}{4}$ those of rats. Possible causes for the observed changes in I^{131} distribution are discussed, in relation to the effects of carnitine and species differences. A possible influence of radiation injury to the thyroid cannot be excluded if the high dose used (10 μC I^{131}) is considered. The thyrotropic hormone activity in the anterior pituitary of the rat is markedly greater than in other animals. It is concluded that L-carnitine does not change the I^{131} distribution in muscle and liver of mice. (BBB)

11563 THE ISOTOPES IN GENERAL BIOLOGY. E. Schram (Université Libre, Brussels). Acta Clin. Belg., 17: 277-83(1962). (In French)

This review concerns general problems associated with isotope applications in biochemistry, techniques of detection and counting, properties of the most frequently used radioisotopes, labeling techniques, and specific applications. The role played by tracers in knowledge gained in photosynthesis is discussed with reference to the chemical reactions involved in the conversion of CO_2 to carbohydrates. (BBB)

11564 USE OF P^{32} IN THE STUDY OF A POPULATION OF SIMULIUM RUGGLESI (DIPTERA: SIMULIIDAE) IN ALGONQUIN PARK, ONTARIO. Gordon F. Bennett (Ontario Research Foundation, Toronto). Can. J. Zool., 41: 831-40(July 1963).

To investigate the means by which blackflies transmit disease, the use of a radioisotope as a marker was explored. The flies were allowed to feed on ducks injected with 0.25-0.5 mc P^{32}, and radiation levels of the ducks blood and of the flies were repeatedly checked. The radiation level in duck blood fluctuated for the first 28 hours following injection; following this period, it decreased until, after 186 hours ($7\frac{1}{2}$ days), the level was about $\frac{1}{3}$ of that at $1\frac{1}{2}$ hours. Assuming no loss of P^{32} from the ducks, the theoretical level at 186 hours should be about 550 counts/mm^3 100 seconds. The measured level in the ducks was ~$\frac{1}{2}$ the theoretical value at 186 hours, the considerable radiation detected in the feces of the ducks possibly accounting for the rapid loss of isotope. Preliminary trials indicated that ducks could be exposed to the biting activity of S. rugglesi at any time after receiving isotope and 12 hours was chosen for convenience. The volume of blood ingested by the flies at a meal was determined from the P^{32} level in flies that had fed on a specific duck as compared to the level in known volumes of whole blood taken from the duck after feeding of flies. A simple calculation converted the radiation level to volume of blood ingested. The blood meal of 56 flies so measured averaged 1.94 (0.48-3.56) mm^3. The large proportion of labeled to unlabeled flies collected in samples suggested that a small population of S. rugglesi was involved. The rate of loss of isotope from the flies appeared to be faster than expected by natural decay of the P^{32}. When the isotope level in the flies taken throughout the study period was compared with the theoretical level expected if the P^{32} was eliminated only by decay, it was seen that S. rugglesi were eliminating P^{32}, as the levels in the flies were lower than expected. Presumably some loss may occur in the eggs at oviposition as found in Aedes aegypti. The results also indicate that in future work, an isotope level of nearly twice that used in this study is required to maintain a detectable level in the flies for periods in excess of 30 days. It is concluded that these studies using P^{32} have shown S. rugglesi to be a mobile, long-lived population, probably involving relatively few individuals. Taking into consideration the strong host and habitat preferences shown by this species, all factors would lead to a rapid and large building up of the infective stage of a parasite in the fly population. As at least one of the parasites, Leucocytozoon simondi, can cause death of the host, control of S. rugglesi in areas where it occurs may be an important adjunct to the improvement of water fowl breeding areas. (BBB)

11565 AUTORADIOGRAPHIC DETECTION OF RADIOACTIVE BACTERIA INTRODUCED INTO SEA WATER AND SEWAGE. Maths Berlin and Ragnar Rylander (Karolinska Inst., Stockholm). J. Hyg., 61: 307-15(Sept. 1963).

A new method, involving radioisotope labeling, is reported as a means of tracing the contamination of water by bacteria. Radioactive substances and dyes have also been used previously to study the spread of contamination, but because of rapid dilution, high levels of radioactivity are necessary to follow dispersion in large volumes of water. Bacteria which have been radioactively labeled can be used as tracer organisms if they can be detected by a method which avoids the necessity of culturing water samples, and if the method is sufficiently sensitive, the use of radioactive bacteria offers several advantages. In the method described, for use in studying the spread of

bacteria in water, water samples were filtered through a Millipore filter and an autoradiogram of the filter was prepared in which the bacteria appeared as black spots. The accuracy and sensitivity of the method were estimated and a test made under field conditions. Strain B Escherichia coli were used, grown overnight at 37°C in medium containing 10 mC $MgS^{35}O_4$ per l. Autoradiographic determination of bacteria was made by diluting 1 ml from each water sample in 500 ml of 0.9% NaCl and filtering the solution through a Millipore filter (type HA, pore size 0.45 μ). The filters were dried at 50°C for 20 min and applied to x-ray film for 10-day exposure. To evaluate the practicability of this autoradiographic method, a study was made of the spread of bacteria from the effluent of a household septic tank which discharged via a sewer into an inlet of the Baltic Sea near Stockholm. Autoradiograms were prepared from water samples obtained before and after radioactive bacteria were added to the sewer. The observed presence in the autoradiograms of images which resembled, but were not caused by radioactive bacteria, were one factor which limits the sensitivity of the method described. These images were found in equal numbers in autoradiograms of filters through which water without radioactive bacteria has been filtered. Thus, the background value must be determined in every experiment before the radioactive bacteria are added to the water. A larger number of bacteria were found in the autoradiograms compared to the number of colonies found on viable count. This may be due to the presence of aged bacteria which no longer give colonies on nutrient agar but still retain their activity. Apparently a thin layer of sludge does not absorb enough radiation from the bacteria to interfere with the autoradiographic results. Because the cells are retained on rather than in the filter, absorption of radiation by the filter is negligible. Hence, the method appears to be suitable for practical use. A small number of bacteria can be detected, and the sensitivity of the method increases if there is less sludge in the water. (BBB)

11566 DOUBLE EMULSION AUTORADIOGRAPHY FOR IDENTIFYING TRITIUM-LABELED CELLS IN SECTIONS. J. W. Pickworth, K. Cotton, and A. P. Skyring (Royal Prince Alfred Hospital, Sydney). Stain Technol., 38: 237-44(July 1963).

The identification of tritium-labeled cells in tissue sections by the conventional autoradiography methods gives high resolution insofar as localization of T is concerned; however, their sensitivity for measuring the radioactivity is low, and only about 0.5 to 2% of the β particles that are emitted from the tissue section during exposure are recorded. Thus large doses of T have to be used. Another disadvantage is that the combination of the low range of Tβ particles and the thickness (4 to 5 μ) of ordinary tissue sections enables some cells which contain the isotope to be visible microscopically but to be such a distance from the emulsion as to be invisible autoradiographically. Thus only a proportion of the labeled cells will be identified. The method described lessens some of these difficulties by using the incorporation of thin tissue sections between 2 layers of photographic emulsion. Thus, the sensitivity of tissue autoradiography can be doubled and the number of false-negative cells nearly eliminated. To demonstrate this, a mouse was given 50 μC of tritiated thymidine intraperitoneally and killed 1.5 hr later. A portion of the small bowel was removed, fixed, and embedded in methacrylate in the usual way. Sections 2 μ thick were cut and allowed to flatten on water at 40°C. Some sections were used to make conventional single emulsion autoradiographs and other sections were interposed between 2 layers of emulsion by first coating slides with NTB 3 emulsion, picking up the sections from a water bath at 18°C, drying, soaking 1 min in benzene, drying, and then dipping again in NTB 3 emulsion. They were exposed at 4°C in a low-humidity, 100% CO_2 atmosphere for 10 days, developed, and covered in the usual way. There was an average of 20.16 ± 1.4 grains per labeled cell in the double emulsion group compared with 10.6 ± 0.9 grains in the single emulsion group. In the double emulsion autoradiograph there were 55.1 ± 1.65 labeled cells per unit area as compared with 39.8 ± 2.0 in the single emulsion group. In the double emulsion autoradiograph the grains were in 2 layers which could be seen simultaneously up to a magnification of 360. The relation between the photographic response of an emulsion to T-labeled cell nuclei in tissue sections is considered and discussed in terms of 2 main factors: the area of radioactive material in intimate contact with the emulsion, and the volume of radioactive material in useful relation to the emulsion. Since for β particles the maximum range in tissue is about 5.5 μ, only a few particles reach this distance and about 50% have been absorbed in the first 0.6 μ. Thus the larger the area of nuclear material which is in immediate contact with the emulsion, the greater will be the response. By using the double emulsion technique with sections of 1 μ and above, the response per nucleus follows closely the curve produced by comparing cut surface area per nucleus and section thickness, and this response will always be double that produced by a single emulsion layer for sections of the same thickness. (BBB)

Ecology

Refer also to abstract 12358.

11567 (PNE-226F) CLOSE-IN EFFECTS OF AN UNDERGROUND NUCLEAR DETONATION ON SMALL MAMMALS AND SELECTED INVERTEBRATES. Donald M. Allred, D. Elden Beck, and Clive D. Jorgensen (Brigham Young Univ., Provo, Utah). Jan. 1, 1963. Project 62.87 of PROJECT SEDAN. Contract AT(04-3)-299. 27p.

Sedan was detonated in the northern portion of Yucca Flat. An ecological study was made to determine the kinds and populations of small animals at pre-determined distances from Ground Zero before and after the detonation. Studies were also conducted to determine the rate and extent of movement of small animals from and into disturbed areas in the vicinity following the explosion, to determine the accumulated γ radiation dose received by small mammals, to determine the protection small mammals received from γ radiation while in their burrows, and to determine which species of invertebrates were present before the explosion that could be used as standards of measurement for the effects of the test on incidence and distribution of species following the explosion. Preliminary analysis of the data show that the threshold area for small mammal disturbance was between 4,000 and 5,000 ft and that animal populations recover from mass destruction or environmental disturbance only as rapidly as the environment becomes suitable for sustaining animal life. Some species of animals were characteristically associated with certain plant communities and biotic populations may fluctuate from one year to the next. (C.H.)

11568 (TID-19562) THE POPULATION STATUS OF THE LARGER VERTEBRATES ON THE ATOMIC ENERGY COMMISSION SAVANNAH RIVER PLANT SITE. Final Re-

port. James H. Jenkins and Ernest E. Provost (Georgia. Univ., Athens). 1963. Contract AT(38-1)-224. 49p.

Results are reported from a survey on the population status of large vertebrates at the Savannah River Plant site. The effects of forest management practices on the wildlife population are discussed briefly. (C.H.)

11569 (UCLA-520(p.81-108)) ENVIRONMENTAL RADIATION. (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology).

Data are presented from measurements of fallout radioactivity in samples of air, precipitation, and vegetation collected at the Nevada Test Site. Data are also included from ecological studies of populations of rodents and lizards at the test site, and the immediate effects of an underground nuclear detonation on soil and vegetation. (C.H.)

Metabolism, Tissue Distribution, and Toxicology

11570 (NP-13555(p.34-45)) THE EFFECTS OF IONIZING RADIATIONS ON THE BIOCHEMISTRY OF MAMMALIAN TISSUES. III. STUDIES ON THE TOXICITY AND MECHANISM OF ACTION OF 2-MERCAPTOETHYLAMINE. Bernard E. Hietbrink and Kei-Ming Yam (Chicago. Univ. Air Force Radiation Lab.).

A study was conducted to determine the effect of dibenzyline, dihydroergotamine, and adrenal demedullation on the mercaptoethylamine-induced increase in the blood glucose level of adult female rats. The results of these studies showed that the administration of dibenzyline or dihydroergotamine 10 min before 200 mg/kg of MEA inhibited the marked increase in blood glucose levels usually observed following this dose of MEA and substantially reduced the duration of action of this sulfur-containing compound. Adrenal demedullation almost completely prevented the increase in blood glucose levels caused by 200 mg/kg of MEA. MEA caused a marked hypoglycemia in the demedullated animals during the latter part of the 5-hr observation period. Results of experiments on the influence of chronic administration of MEA on the blood glucose level of the rat indicated that repeated doses of MEA do not appear to cause drug tolerance. Studies on the influence of MEA on the acetylcholinesterase activity of the brain and serum of rats indicated that the gross toxic symptoms observed following the administration of MEA were not due to cholinesterase inhibition. The results of preliminary studies on the influence of sodium pentobarbital on the acute toxicity of MEA indicated that 25 mg/kg of pentobarbital prevented the lethal effect of doses of MEA as great as 325 mg/kg. (auth)

11571 (NP-13572) HEMORRHAGIC SYNDROME IN RATS FED IRRADIATED BEEF. Progress Report No. 8, March 1, 1963 to September 15, 1963. E. A. Doisy, Jr., and J. T. Matschiner (Saint Louis Univ. School of Medicine). 17p.

Rats fed irradiated beef showed no evidence of a noxious substance intensifying the hemorrhagic syndrome. An attempt was made to determine differences in the content of vitamin K in fresh and irradiated beef. Results of biossay for vitamin K activity in rats and chicks are reported. (C.H.)

11572 (NP-13573) ON THE NUTRITIVE VALUE OF THE MAJOR NUTRIENTS OF IRRADIATED FOODS AND APPRAISAL OF THE TOXICITY OF IRRADIATED FOODS. Progress Report No. 24, March 1, 1963–September 1, 1963. Roberta Bieiler Hill and B. Connor Johnson (Illinois. Univ., Urbana). Contract DA-49-007-MD-544. 14p.

Rats fed soya protein, vitamin K-deficient diets apparently practiced coprophagy to a greater extent than did rats given irradiated beef diets. Thus, when animals were housed in standard cages, those fed irradiated beef showed signs of hemorrhage diasthesis earlier than did those fed the soya protein diet. Liver prothrombin activity was concentrated in the microsomal fraction. Ultrasonication compared to incubation of microsomes released more prothrombin, and vitamin K_4 was ineffectual in enhancing this release. The relation that exists between microsomal and plasma prothrombin was demonstrated directly. With time, after treating control rats with dicumarol, microsomal prothrombin decreased and plasma prothrombin time increased. After injection of vitamin K-deficient rats with vitamin K_1 the process was reversed. (auth)

11573 (TID-20106) ACTION OF TRITIATED TETANUS TOXIN AND TOXOID UPON THE ANTIBODY-FORMING MECHANISM. [Period Covered]: April 1, 1963–March 31, 1964. Robert Speirs (New York. State Univ., Albany. Research Foundation). Dec. 1963. Contract AT(30-1)-3024. 13p.

Progress is reported in studies on the localization of tritiated polysaccharides in immunized and non-immunized mice, mechanisms of hypersensitivity and immunity, the initiation of antibody production in irradiated mice, and the augmentation of immunity in mice by cell-free extracts. (C.H.)

11574 (UCLA-520(p.15-25)) BIOCHEMISTRY. (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology).

Data are presented on the lipid components in human brain as a function of aging; the direct effects of γ radiation on long-chain fatty acids; the composition of wax esters of the flesh of the genphylidae fish, Lepidocybium flavo-bruneum; the requirements in the culture medium for growth and maintenance of beating heart cells; and metabolic studies in beating heart cells in culture. (C.H.)

11575 (UR-639) STRONTIUM-90 TOXICITY IN RAT EMBRYO. B. J. Hopkins, G. W. Casarett, L. W. Tuttle, and R. C. Baxter (Rochester, N. Y. Univ. Atomic Energy Project). Feb. 10, 1964. Contract W-7401-eng-49. 18p.

Gestating rats were injected intravenously with doses of 191 or 382 μC of Sr^{90} on the 2nd, 10th, and 17th days post-conception. Examination of implantation sites on the 20th day post-conception showed that the injection of Sr^{90} on day 2 post-conception caused a significant increase in fetal mortality and growth retardation, greater in degree after the larger dose, and that injection of Sr^{90} on the 10th post-conception day retarded growth and increased mortality (slightly) only after the larger dose. The maternal hematocrit was lowered significantly at both dose levels following Sr^{90} injection on either the 2nd or 10th day post-conception, and this effect was greater in those injected on day 2 post-conception. The hematocrit of fetuses of Sr-injected rats was decreased slightly, but not significantly. The injection of either 191 or 382 μC of Sr^{90} on day 17 post-conception did not cause any apparent differences from control values in body weights and numbers of viable offspring per litter at parturition. There was an increased daily cumulative mortality in offspring

of Sr-treated rats during the first week of life, but this was no longer evident by one month of age. (auth)

11576 (AEC-tr-6331) STUDIES OF HUMAN Ca-METABOLISM WITH Ca^{47}. P. Doering. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Klin. Wochschr., 41: 681-90(July 15, 1963). 27p.

Calcium-47 was used for the study of the Ca metabolism in seven male patients aged between 54 and 68. Besides the exchangeable Ca pool and its daily value of metabolism, the daily assimilation rate in the skeleton and rate of endogenous Ca excretion into the intestine and into the urine was determined. The urine-Ca excretion determined from the Ca^{47} experiments showed good agreement with the directly determined values of the daily renal Ca excretion. Calculations of the radiation exposure yielded for the applied activity amounted to doses of 0.5 rem for bone as the critical organ and constitute therefore a tolerable radiation exposure. (auth)

11577 AUTORADIOGRAPHY OF VARIOUS RAT TISSUES AFTER THE ADMINISTRATION OF BISMUTH 210. C. J. H. Van den Broek (Universiteit, Utrecht). Acta Radiol. (N.S.), 1: 385-96(Dec. 1963).

Rats were injected intravenously with doses of $Bi^{210}Cl_3$ and counts and distribution studies of the tracks of autoradiograms of various tissues were performed. Track distribution in most cases conformed to the random distribution, the only exceptions being a high accumulation in the proximal tubules of the kidney and a slight accumulation in the macrophages of the spleen. (auth)

11578 AUTORADIOGRAPHIC LOCALIZATION OF STRONTIUM 85 IN OSTEOSARCOMAS. L. E. Appelgren, A. Nilsson, and S. Ullberg (Royal Veterinary Coll., Stockholm and Research Inst. of National Defence, Sundbyberg, Sweden). Acta Radiol. (N.S.), 1: 459-64(Dec. 1963).

Improved resolution was obtained with strontium-85 as compared with strontium-90, in autoradiographic investigations of the distribution of radiostrontium in bone-forming osteosarcomas. A much higher uptake of radiostrontium was found in tumor that in normal bone, the distribution being highly irregular and related to the varying degrees of mineralization and degenerative changes. (auth)

11579 SIMULTANEOUS STUDIES OF PHOSPHATE TRANSPORT AND GLYCOLYSIS BY A SIMPLE LIQUID SCINTILLATION COUNTING PROCEDURE WITH P^{32}, C^{14}, AND H^3 COMPOUNDS. Ray Wu (Public Health Service Research Inst., New York). Anal. Biochem., 7: 207-14 (Feb. 1964).

The simultaneous use of P_i^{32}, C^{14}-glucose, and H^3-inulin in studying P^{32} transport and glycolysis in kidney slices is described, together with a simple and accurate counting procedure for triply labeled samples in the liquid scintillation spectrometer. Three independent methods were used for the measurement of glycolysis, and C^{14}-lactate determination was found to be the most suitable. The P^{32} transport in rat kidney slices was found to be entirely dependent on aerobic metabolism. (auth)

11580 EXAMPLES FOR RAPID LABELLING METHODS USING THE INSTRUMENT "SIGNETTE." E. H. Graul, H. Hundeshagen, H. Kuni, and E. Schaumloeffel (Philipps-Universität Marburg/Lahn, Ger.). Atompraxis, 10: 53-5(Jan. 1964). (In German)

Uses of the Signette for rapid labelings are described. A method for blood volume determination, using Cr^{51}-labeled erythrocytes, makes it possible to measure the activities in a bore-hole scintillation counter in a way similar to using the semi-automatic instrument Volumetron. The method is declared in detail. The error of volume determination was found to be lower than 3%. Measurements in comparison with the Volemetron showed good agreement in the results in model-tests as well as in the determination of blood volumes on patients. The possibility of using the Signette for $I^{131}-T_3$ in vitro thyroid function tests is described. The first preliminary results of experiments brought significant differences between euthyroid and hyperthyroid patients. (auth)

11581 EFFECT OF SOME RADIOPROTECTORS ON THE ENZYMATIC SYSTEM OF MICROSOMES DEGRADATION OF LIVER HEXOBARBITAL. C. Liébecq, Z. M. Bacq, and Alexandra Thomou (Université, Liege). Biochem. Pharmacol., 13: 51-8(Jan. 1964). (In French)

Various so-called radioprotectors were tested for their ability to interfere with the metabolism of hexobarbital by sub-cellular fractions of the rat liver in vitro. Cystamine (1.5×10^{-3} M) and 5-hydroxytryptamine (10^{-3} M) produced a 50% inhibition of the utilization of hexobarbital by liver homogenates prepared in phosphate buffer, freed of the nuclear and mitochondrial fractions, and supplemented with nicotinamide adenine dinucleotide phosphate (NADP) and magnesium ions. Cysteamine and histamine were less effective. The reduction of NADP by added glucose-6-phosphate in the presence of the glucose-6-phosphate dehydrogenase of the soluble fraction of the liver homogenate was unaffected by the compounds tested. The reoxidation of the reduced form of NADP by oxygen in the presence of the microsomes was inhibited by cystamine and 5-hydroxytryptamine; this process was initially stimulated and later inhibited by histamine, initially unaffected, and later inhibited by cysteamine. (auth)

11582 THE DISTRIBUTION OF ^{32}P IN RIBONUCLEIC ACID FROM NUCLEATE AND ANUCLEATE HALF CELLS OF AMOEBA PROTEUS. Joseph E. Cummins and W. Plaut (Univ. of Wisconsin, Madison). Biochim. Biophys. Acta, 80: 19-30(Jan. 20, 1964).

Nucleate and anucleate half cells of Amoeba proteus were labeled with [P^{32}] orthophosphate and the distribution of P^{32} among the labeled nucleotides was examined. Both nucleate and anucleate half cells were capable of incorporating orthophosphate into RNA. The anucleate half cell, however, incorporated P^{32} at a slower rate than did the nucleate half cell and there was a diminution in the relative rate of P^{32} incorporation into the anucleate half cell with time after enucleation. Irrespective of the rate of P^{32} incorporation the distribution of P^{32} label among the nucleotides of RNA following alkaline degradation was not significantly different between the ribonucleotides in anucleate and nucleate half cells. Several methods of RNA preparation demonstrated that the orthophosphate incorporation was in fact attributable to a polyribonucleotide. It was further shown that the radioactivity was primarily associated with 2',3'-nucleotides following alkaline degradation of the labeled RNA, ruling out the possibility of a nucleotide-binding phenomenon. Filtration experiments suggested that the labeled cytoplasmic RNA was not bound to stable particles of a diameter greater than 50 mμ. Finally the half cells were fractionated by centrifugation and the distribution of P^{32} in RNA of these fractions was analyzed. The fractionation experiments led us to conclude that RNA associated with the microsomes contains much of the label in nucleate and anucleate half cells. The RNA of the microsomes has similar distributions of P^{32} in both nucleate and anucleate half cells and these distributions were similar to the total half-cell distributions of P^{32}. The soluble fractions of both half cells had distinctly different distributions of P^{32} from the micro-

somal fractions and the soluble fractions of nucleate and anucleate half cells were different from each other. (auth)

11583 INCORPORATION OF ^{32}P INTO THE RIBONUCLEIC ACIDS OF RABBIT RETICULOCYTES. A. Burny and H. Chantrenne (Université, Brussels). Biochim. Biophys. Acta, 80: 31-8(Jan. 20, 1964). (In French)

Radioactive phosphate is incorporated very slowly into RNA of rabbit reticulocytes in vitro. A large part of the incorporated phosphate belongs to the terminal adenylic residue of transfer RNA. The rate of synthesis of RNA was estimated by comparing the specific activity of the α-phosphate group of ATP to that of RNA nucleotides. The rate of synthesis of polynucleotide chains averages 0.5% in 6 hours. (auth)

11584 STUDIES ON RAPIDLY LABELED RIBONUCLEIC ACID IN HeLa CELLS. M. Hill, A. Miller-Faurès, and M. Errera (Université Libre, Brussels). Biochim. Biophys. Acta, 80: 39-51(Jan. 20, 1964).

A study of the sedimentation pattern in sucrose gradients of rapidly-labeled RNA (5–30 min labeling with [C^{14}] adenine) was done on whole extracts of HeLa cells. Two regions of radioactivity were found: a lighter region sedimenting in the range of 4 to 20-S particles and a heavier heterogeneous region sedimenting from about 30 S to the bottom of the gradients even when 30% sucrose was used. The nature of the various types of RNA's likely to sediment in these regions is discussed. The heavier heterogeneous region contained very small amounts of DNA, but no definite evidence for the existence of DNA–RNA hybrids was obtained. On the other hand, the heavy heterogeneous region is active in amino acid incorporation and consisted of a variety of polysomes; their characterization by electron microscopy is described in a further paper. The polysomes, after a short labeling period, consist of unlabeled 74-S ribosomes to which is attached rapidly-labeled RNA; it was shown that it takes roughly 5 minutes for [C^{14}] adenine to become integrated into RNA sedimenting with the polysomes. Comparison of autoradiographic and sedimentation analysis shows that a large proportion of the polysomes might be formed in the cell nucleus. (auth)

11585 SOME OBSERVATIONS ON THE METABOLISM OF RADIOCALCIUM AND RADIOSTRONTIUM. B. E. C. Nordin, D. A. Smith, and J. Nisbett (Gardiner Inst., Glasgow). Brit. J. Radiol., 37: 89-94(Feb. 1964).

The fate of intravenously administered radiocalcium and radiostrontium is briefly described. The discrimination by the kidney in favor of strontium is discussed in relation to the rate of urinary calcium excretion. The difference between net and true absorption of calcium is to find the effect of calcium on each of its parameters described. Plasma activity after oral administration of radiostrontium and radiocalcium was found to reach a peak at about 2 hours and the effect of carrier on peak activity is shown. The excretion in the feces and urine of continuously ingested isotope is described and discussed. (auth)

11586 THE METABOLISM OF THE TRANSURANIC ELEMENTS. D. M. Taylor (Royal Cancer Hospital, London). Brit. J. Radiol., 37: 95-100(Feb. 1964).

The metabolic behavior of the transuranic group of elements is reviewed briefly. In general these elements are poorly absorbed from the gastrointestinal tract and the absorbed material is deposited mainly in the liver and skeleton. Skeletal retention is prolonged and is probably similar for all the elements in the group. It is suggested that the metabolic behavior of the trivalent elements from americium to nobelium will be qualitatively similar. (auth)

11587 THE METABOLISM OF RADIOIODINE AND RADIATION DOSAGE IN MAN. K. E. Halnan (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Brit. J. Radiol., 37: 101-7(Feb. 1964).

The metabolism of iodine in man is briefly considered in relation to radiation dosage from radioactive iodine. The different isotopes of iodine are enumerated and their properties and uses mentioned. Radiation dosage to the thyroid gland and to the various tissues of the body is estimated, with special reference to I^{131}, I^{132} and I^{133} and attention is drawn to the relatively high dose given to the infant's thyroid, high mainly because of the low gland mass. Alteration in radioiodine metabolism because of thyroid disease and of administration of drugs is discussed. The hazards of radioiodine and methods of protection therefrom are considered. It is suggested that iodide administration is the most useful method. (auth)

11588 A SURVEY OF THE METABOLISM OF CAESIUM IN MAN. J. Rundo (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Brit. J. Radiol., 37: 108-14(Feb. 1964).

Present knowledge of the metabolism of cesium in man is reviewed; data on stable cesium in autopsy materials, as well as on radioactive cesium both in autopsy material and in vivo are considered. Cesium is distributed widely throughout the body but is mainly in the soft tissues; the concentration in rib appears to be higher than in cortical bone (femur). Uptake of cesium chloride from the gastrointestinal tract is rapid and essentially complete. Excretion is principally via the urine, but there is a continuing loss in the feces whether the administration was by ingestion or intravenous injection. The urinary/fecal excretion ratio ranges from less than 2 to more than 10 among individuals, but is reasonably constant in any one subject. The wholebody retention of cesium can be expressed by a two-component exponential function of time; some 6-15 (mean about 10) per cent of a single oral dose is excreted with a short half-life (1-2 days), but the major part has a half-life between 50 and 150 (mean 110 days) with isolated cases reported of up to 200 days. This variability may account to a large extent for the considerable range of fallout cesium 137 contents which were reported. (auth)

11589 AN OUTLINE OF THE METABOLISM OF INHALED AND INGESTED INSOLUBLE RADIONUCLIDES. I. S. Eve (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.). Brit. J. Radiol., 37: 115-20(Feb. 1964).

The fate of insoluble radionuclides after inhalation is discussed, with particular reference to the human case. The influence of deposition, clearance and translocation of particles in the lung is described. The clearance of radioactive particles from the lung by ciliary action leads to irradiation of the gastrointestinal tract, and this is also briefly discussed. (auth)

11590 PREPARATION OF PURIFIED I^{131}-LABELED ANTIBODY WHICH REACTS WITH HUMAN FIBRIN. PRELIMINARY TRACER STUDIES ON TUMOR PATIENTS. Irving L. Spar, William F. Bale, Ruth L. Goodland, and Mary Jane Izzo (Univ. of Rochester, N. Y.). Cancer Res., 24: 286-93(Feb. 1964).

Techniques are described for preparing, from sera of rabbits immunized with human fibrinogen, I^{131}-labeled antibody reacting with fibrin and suitable for diagnostic use as an intravenously administered tracer in human patients. The final purified sterile preparations contained I^{131} label at a level of approximately 10 mc I^{131}/mg rabbit antibody protein. The labeled preparation almost quantita-

tively bound to freshly formed human fibrin in the presence of the serum proteins but did not bind to rabbit fibrin. Twenty-eight human patients were given injections intravenously of this type of preparation with no untoward effects. Scintillation scanning of the head area of those patients with known or suspected brain tumors indicated that preparations of this type may be useful for diagnosis and delineation of those lesions. Possibilities of increasing the effective preferential localization of this radioactive material in tumors for diagnostic or therapeutic purposes by the concurrent use of epsilon amino caproic acid, or other inhibitors of plasminogen activation or plasmin activity, are discussed. (auth)

11591 THE MUTAGENIC AND ANTIMUTAGENIC ACTION OF SODIUM GALLATE. V. A. Baraboi and G. S. Yukova. Dokl. Akad. Nauk SSSR, 153: 1193-4(Dec. 11, 1963). (In Russian)

It was found previously that reagents such as streptomycin or cysteamine can slow down the natural mutagenic rate, and are also protective agents against the genetic effects of ionizing radiation. Since sodium gallate is a protective agent, experiments were run on the Russian horse bean Vicia faba to determine the effect of sodium gallate on the natural mutation rate. The moistened seed were maintained at 25°C for 48 hours, were germinated at 25°C for another 24 hours, and then, were treated with 0.00001, 0.0001, 0.001, 0.01, 0.1, 1.0, and 100 γ/ml of sodium gallate for the next 24 hours. The number of chromosomal aberrations during anaphase was counted. A concentration of 0.00001 γ/ml of sodium gallate showed only 9.4% fragments during anaphase compared to 23.1% in the controls. As the concentration of sodium gallate was increased to 1.0 γ/ml, a moderate mutagenic effect was noted. The maximum effect of 44.8% fragments during anaphase was observed at 10 γ/ml of sodium gallate. This maximum rate is double the natural mutation rate. The effect of gallates on the mutagenesis induced by radiation is being investigated. (TTT)

11592 METABOLISM OF I^{131} BY DAIRY COWS DURING LONG TERM DAILY ADMINISTRATION OF THE RADIOISOTOPE. F. W. Lengemann and C. L. Comar (Cornell Univ., Ithaca, N. Y.). Health Phys., 10: 55-9(Feb. 1964).

The results of fifteen trials on nine cows given I^{131} twice daily for about 14 days are presented. The cows showed a thyroid I^{131} level equivalent to 79% of a daily dose, put about 1% of the daily dose of I^{131} into each liter of milk, and showed a milk/plasma I^{131} ratio of 2:3. Approximately 5% of the I^{131} of the milk was found to be protein bound at the end of 2 weeks of receiving I^{131}. The total I^{131} found in milk, thyroid, and whole body was followed in two cows from the start of I^{131} dosing. When the decay of I^{131} was accounted for, the per cent of milk I^{131} was found to plateau at about 8 days while that of the body and thyroid did not plateau during the experiment. The amount of I^{131} in milk was maximum at about 3 days and reached a peak in the thyroid and body at about 10 to 8 days, respectively. Data are presented to show that the level of stable iodine in the diet of the cow may affect the movement of I^{131} into milk. (auth)

11593 TRITIATION OF AN ANTI-γ-GLOBULIN AND RADIOCHEMICAL DOSIMETRY. R. Cardinaud, K. Takashima, J. Dausset, and P. Fromageot (Commissariat à l'Energie, Paris). Intern. J. Appl. Radiation Isotopes, 15: 1-9(Jan. 1964). (In French)

A preparation of anti-γ-globulin was exposed to tritium gas and the effect of various experimental conditions on the specific radioactivity and the immunological activity of the tritiated antiglobulin was examined. The experimental conditions for reproducibility of measurements were studied, also the specificity limits of the immunological reaction employed, and the influence of the antiglobulin concentration on this reaction. The data obtained show that, as compared with simple exposure to tritium gas, activation of the latter by high-frequency discharges leads to more rapid exchange, whereas the degree of destruction of the biological activity is not increased in the same proportion. (auth)

11594 FEED ADDITIVES: METABOLIC STABILITY OF RADIOACTIVE ARSANILIC ACID IN CHICKENS. L. R. Overby and R. L. Fredrickson (Univ. of Illinois, Urbana). J. Agr. Food Chem., 11: 378-81(Sept.-Oct. 1963).

An investigation of its possible metabolic alterations showed that arsanilic acid is metabolically stable when used in medicated feeds of chickens. The ratio of C^{14} to As^{74} in a double-labeled molecule did not change. Unlike arsenate-As^{74}, no radioactivity was expired from arsanilic-As^{74} acid. Arsanilic acid was found unchanged in excreta. Neither arsenate metabolic products nor reduced forms of arsanilic acid were found in tissues. Residual arsanilic acid in edible tissues was handled like authentic arsanilic acid in second animals. This conclusion is based on experiments done with As^{74}- and C^{14}-labeled arsanilic acid. In double-labeled C^{14}-, As^{74}-arsanilic acid, the two isotopes remained in constant proportions in all the various body compartments. Secondly, there was no expired As^{74} after administration of arsanilic-As^{74} acid. Thirdly, arsanilic acid was excreted intact. Fourthly, arsenate metabolites were not detected in tissues of chickens given arsanilic acid. Finally, tissues containing arsanilic acid residues were handled like authentic arsanilic acid when fed to second test animals, including man. A rupture of the carbon-arsenic bond in arsanilic-1-C^{14}, -As^{74} acid would leave C^{14}-labeled aniline and As^{74}-labeled arsenate. Through normal differential metabolism the two isotopes would go their separate ways. They would not stay together in any consistent manner. But if the bond were not ruptured, the ratio of C^{14} to As^{74} would always remain constant, regardless of whatever happened to the rest of the molecule. Chicks were fed double-labeled arsanilic acid and the counting rates of the two isotopes were differentially determined in tissues taken 48 hours after the dose. The dose ratio, tissue ratio, and excretory ratio of C^{14} to As^{74} were the same, within the limits of experimental error. Thus, if the carbon-arsenic bond of arsanilic acid were ruptured by chicks at all, it was much less than 1% of the administered dose. Other experiments showed that the radioactivity in tissues cleared in a first-order reaction, very much the same as blood. The results were consistent with the idea that arsanilic acid was translocated in the body rather than transformed. (BBB)

11595 STRONTIUM^{90} AND MILK: ESTIMATES OF THE DIETARY SIGNIFICANCE OF CHANGES IN MILK CONSUMPTION. B. L. Larson (Univ. of Illinois, Urbana). J. Dairy Sci., 46: 759-63(Aug. 1963).

Two principal conclusions derived from a survey attempting to assess the role of milk in the diet in the Sr^{90} problem were that owing to discrimination by the cow against Sr^{90} in plant foods in favor of Ca, milk in the United States has contained a lower level of Sr^{90} per unit of Ca than the average nonmilk portion of the diet, and owing to discrimination by the human, the Sr^{90} level that deposits in bone is about $\frac{1}{4}$ of the Sr unit (S.U.) level in the total diet and, thus, is dependent on the Ca level as well as the Sr^{90} level in the total diet. A corollary is that

even though milk has been the largest contributor of Sr^{90} to the diet from any one food source, its inclusion in the average diet in the United States should reduce the Sr level, and thus, the bone deposition level of Sr^{90} below that which would result from the same average diet, not including milk. Estimates are made to relate the effects of possible changes in milk consumption on the resultant Sr^{90}/Ca ratio in the diet. Analysis of the Sr^{90}/Ca ratios that have been observed in milk and the remainder of the diet indicate that postulated practices, such as the removal of most of the Sr^{90} from milk, might actually increase the bone deposition level of Sr^{90} if accompanied by a significant decrease in milk consumption. To relate the role of milk in the diet, the Sr unit level in the total diet (including milk) to that in milk was compared. Data are included from analyses of the average diet consumed in New York, Chicago, and San Francisco from 1960 to 1962. Results are reported from recent studies that indicate that a 30% drop in milk consumption at a Total Diet/Milk (TDM) ratio of 1.6 would raise the S.U. unit level in the resultant diet 20%; the complete removal of milk at this TDM ratio would raise the S.U. level 70%. It is concluded that milk, instead of increasing, is effective in decreasing bone levels of Sr^{90}. Estimates of the magnitude of this effect indicate that it is large enough to be a serious consideration in any dietary change, which might result from or be related to the Sr^{90} situation, and involves a potentially significant change in milk consumption. It is considered that the present levels of Sr^{90} in foods are not at a level high enough to cause undue public concern, and that removal of Sr^{90} from milk is unwarranted at present. (BBB)

11596 EFFECT OF FATTY ACID ON THE IODINATION OF BOVINE SERUM ALBUMIN. A. N. Glazer and F. Sanger (Lab. of Molecular Biology, Cambridge, Eng.). J. Mol. Biol., 7: 452-3(Oct. 1963).

The influence of the presence of stearic acid bound to bovine serum albumin (BSA) on the iodination of the protein with I^{125} and I^{131} was investigated. Defatted BSA (0.2 μmole) was dissolved in 0.8 ml 0.2M Na_2HPO_4 and this was added to 0.4 μmole stearic acid in 10 μl absolute ethanol. The solution was allowed to stand until it had become completely clear, or about 30 min. The solution was then mixed with 0.5 ml (1.65 μatom I) of the stock iodine monochloride solution containing 2 μC I^{131}/ml. The pH of the resulting reaction mixture was 7.7. After 10 min. at room temperature, the iodinated protein was precipitated by the addition of 0.4 ml of a trichloroacetic acid-mercaptoethanol-NaI solution. The precipitates were washed, then subjected to partial acid hydrolysis at 37°C in concentrated HCl. The hydrolysates were examined by paper electrophoresis followed by radioautography. Qualitatively identical patterns were obtained at the level of 4 and 7 atoms I incorporated per mole BSA. A number of additional peptides are present in the hydrolysate of serum albumin iodinated in presence of fatty acid as compared with the hydrolysate of the iodinated defatted protein. The data suggested that the binding of 2 moles of stearic acid to defatted BSA is associated with a conformational rearrangement resulting in the accessibility of a greater number of tyrosine residues to iodination. (TCO)

11597 RADIOISOTOPIC LOCALIZATION IN SUBDURAL HEMATOMAS: AN EXPERIMENTAL STUDY WITH ARSENIC-74 AND RADIOIODINATED HUMAN SERUM ALBUMIN IN DOGS. John Mealey, Jr. (Indiana Univ., Indianapolis). J. Neurosurg., 20: 770-6(Sept. 1963).

Observations were made of the differential qualitative and quantitative uptakes of As^{74} and I^{131}-labeled human serum albumin (RISA) in experimental subdural hematomas and adjacent tissues of dogs to augment results available from human biopsy samples, and to elucidate more fully the nature and magnitude of the uptake of these isotopes in hematomas. Intracranial distribution of the isotopes was studied in 20 dogs with experimental subdural hematomas, 7–41 days old. Radioautography and radioassay of samples were used to determine and compare the uptakes of the two isotopes in these lesions and contiguous tissue. Concentrations of both isotopes were higher in the subdural membranes than in the more inert contents of the hematomas or subjacent cerebral cortex. This contiguous cortex in turn contained somewhat higher activities of the isotopes than did cortex from the normal hemispheres. Ratios of the concentrations in the subdural hematomas to underlying brain were greater with RISA than with As^{74}, suggesting the preferential use of RISA for clinical scanning. These studies indicate that it is the nature of the subdural membranes that largely determines the extent of the uptake of As^{74} or RISA about subdural hematomas. The similarity of these experimental data to the results found in clinical biopsy material indicated that these observations can be applied to man. The higher activity of RISA found in cortex subjacent to the hematoma relative to normal cerebral cortex may aid in the lateralization of these subdural lesions in scanning. The chief disadvantage of the use of RISA in the detection of subdural hematomas as compared to scanning with As^{74} is the tendency of RISA to remain at higher levels in the blood. Thus, normally in the scan the activity is higher over the cranial periphery. Since this experimental study, subdural hematomas also were demonstrated more clearly by photoscanning with Hg^{203}-tagged Neohydrin, and recent experience here with this newer agent in three patients suggests that subdural hematomas may be detected more readily by scanning with it than with either As^{74} or RISA. (BBB)

11598 DEPOSITION OF Ba IN AORTIC TISSUE. R. Brinkman and H. B. Lamberts. Koninkl. Ned. Akad. Wetenschap., Proc., Ser. C, 66: 231-5(1963).

Selective binding of traces of Ba is shown by the high affinity of polysulfate mucopolysaccharides for this ion. For chondroitin sulfate relative affinities of the cations Ca, Sr, and Ba roughly increase in the order of two to three to four. On the assumption that the accumulation of Ba and Sr in aortic tissue might be relevant to the polysulfate mucopolysaccharide matrix of the aortic intima, more evidence was obtained for this preferential deposition of Ba by the analysis of human aortas and by injection of Ba^{140} salts in rats. The analysis of human aortas, of all ages, was made by emission spectrography of the dry powdered ashed tissue. Of 69 human aortas, from patients of various ages, 48 had Ba contents from very low to 40 μg/g ash; this agrees with the values from literature. In 21 cases the contents were higher, up to 2325 μg/g ash. Thus, in many cases Ba had an aortic concentration which was much above the general figure for soft tissues. No attempt was made to measure Sr, but Sr too may show this aortic preference. From radioautographs of sections from mice, injected previously with Sr salts, a selective deposition in the aortic wall is seen, at least at some minutes after injection. For evaluation of the higher Ba values which were found in aortic tissue of young humans, it must be considered that the ash content of young aortic tissue is much lower; calculated on fresh wet tissue, the Ba content is not increased in young aortas over the mean value for all ages. On the other hand, it is seen that the deposition of Ba is

present already in very young individuals. The distribution of Ba^{140} from injected solutions in rats 24 hours after injection is shown (50 μC was injected intravenously, intraperitoneally, and subcutaneously). In this preliminary acute experiment, most of the injected $Ba^{140}Cl_2$ must have been excreted and the initial deposition occurred in bone. The aortic wall, 24 hours after injection, has collected 10-20 times the muscle concentration and ⅓ to ½ of the ocular deposition. Traces of $Ba^{140}SO_4$ were given rats to learn something about the resorbability of $BaSO_4$ from the intestine and to study Ba^{140} distribution in chronic experiments. To a neutralized solution of $Ba^{140}Cl_2$ an excess of stable $BaCl_2$ was added, and by addition of Na_2SO_4 a suspension of $BaSO_4$, containing a trace of $Ba^{140}SO_4$ was obtained. Of this suspension 37.5 μC was given by stomach tube to rats; 24 hours later they were killed and activities of various organs were counted. It appeared that preferential deposition in aortic tissue is much more pronounced if Ba^{140} enters the circulation more slowly. The distribution in various organs was measured nine weeks after a single oral ingestion of $Ba^{140}SO_4$. The results suggest a tendency towards continuing aortic deposition over longer times. (BBB)

11599 THE EFFICACY OF EARLY USE OF ARTIFICIAL KIDNEY IN LETHAL AFFECTION OF DOGS WITH INCORPORATED Sr^{90}. M. G. Petrovnin. Med. Radiol., 8: No. 12, 31-7(Dec. 1963). (In Russian)

In experiments staged on dogs, the artificial kidney was used 5 minutes after subcutaneous administration of a lethal dose of Sr^{90} (0.45 μC/kg). When the hemodialysis ranged 4½ hours 29% of the introduced or 52.6% of skeletal Sr^{90} was eliminated from the dog's organism. If the duration of hemodialysis was increased to 6 hours the quantity of Sr^{90} eliminated from the organism augmented to 38.3 and 60.2% correspondingly. After 6-hour hemodialysis the Sr^{90} concentration in the blood was still nearly 8 times higher than in the dialyzing solution. It was also disclosed that in subcutaneous introduction of a solution of hydrochloric radiostrontium its concentration in the blood rises rapidly attaining the maximum in 3–4 hours; in 24 hours it is relatively low. The data point to the possibility of a more effective employment of the artificial kidney at later periods (in 2–3 hours) after subcutaneous injection of a solution of hydrochloric radiostrontium. (auth)

11600 CHANGES OF THE GASTRIC SECRETION IN PERORAL ADMINISTRATION OF RADIOSODIUM. S. R. Perepelkin. Med. Radiol., 8: No. 12, 38-42(Dec. 1963). (In Russian)

The functional shifts of the normal and vagotomized stomach in chronic peroral administration of radiosodium (5 μg/kg) against the background of strong (meat) and weak (milk) food stimuli were investigated. In these conditions there was seen a wavelike character of disturbances of the gastric secretion. The markedness of changes towards an inhibition of secretion depended on the use of a strong food stimulus, the number of radiosodium administrations, and the conduction of vagotomy. Individual fluctuations in the content of the gastric juice and its enzymatic activity were also observed. In the majority of dogs at the end of the experiment, after 3–5 administrations of Na^{24} an admixture of blood was seen in the gastric juice. Postmortem investigations revealed punctate-focal hemorrhages in different regions of the stomach; in one dog there was noted a small ulcer on the mucous surface of the miniature stomach. The results testify to the fact that in radiation pathology dystrophy develops in the stomach. Parabiosis, apparently, comprises its basis. The latter is confirmed by the sharply undulating nature of the gastric secretion, its significant inhibition in the administration of a strong food stimulus, as well as in increase of the total dose of radiosodium. (auth)

11601 RE-UTILIZATION OF THYMIDINE DURING DEATH OF A CELL. Yosh Maruyama (Stanford Univ., Palo Alto, Calif.). Nature, 201: 93-4(Jan. 4, 1964).

Following large doses of x radiation, death of a murine ascites lymphoma cell occurred by a rapid intermitotic mechanism. The desoxyribonucleic acid (DNA) of these cells was labeled with tritiated thymidine, the cells killed by x-irradiation, and injected intravenously into recipient mice with growing ascites tumors. Tritium appeared in the DNA of the tumor and bone marrow cells of the recipient mice, with all the radioactivity present as thymine. This indicated a salvage and conservation mechanism for these molecules. (M.C.G.)

11602 DEPENDENCE OF THE ELECTRICAL CONDUCTIVITY OF BARLEY SEEDS ON TEMPERATURE. John Read (Wakari Public Hospital, Dunedin, New Zealand). Nature, 201: 94(Jan. 4, 1964).

It was found that when a barley seed, with a water content of about 9 wt %, is heated from 20 to 90°C the conductivity increases by a factor that is generally between 200 and 300. The maximum conductivity increases with moisture content and a decline in conductivity above 90° with increasing temperature is attributed to loss of water vapor. (M.C.G.)

11603 INHIBITION OF THE GROWTH OF IMPLANTED MOUSE CARCINOMA BY AN IRRADIATED BACTERIAL CULTURE. Charles A. Pannett (Royal Coll. of Surgeons of England, London). Nature, 201: 404-5(Jan. 25, 1964).

Ingestion of live Escherichia coli cultures by mice was reported to inhibit the growth of an implanted mouse mammary carcinoma. A filtrate prepared from a 48-hour E. coli culture was irradiated with a dose of 150,000 r. Mice grafted with Compton 22 mouse mammary carcinomas were given the irradiated liquid either orally or by subcutaneous injection. Tumor growth was inhibited by the irradiated bacterial filtrate independent of the method of administration. The experiments serve to demonstrate that in order to obtain the tumor-inhibition effect it is unnecessary for live bacteria to enter the alimentary canal. (H.M.G.)

11604 DIFFERENCES IN THE DISTRIBUTION OF ZIRCONIUM-95 AND NIOBIUM-95 IN THE RAT. B. V. Rama Sastry, Lillian K. Owens, and Con O. T. Ball (Vanderbilt Univ., Nashville). Nature, 201: 410-11(Jan. 25, 1964).

Physical decay patterns of $Zr^{95}-Nb^{95}$ were determined in rat tissues to show whether some tissues prefer Zr^{95} while others concentrate Nb^{95} in four days after interperitoneal administration of $Zr^{95}-Nb^{95}$ in transient equilibrium. Twelve male Sprague-Dawley rats were injected with carrier-free $Zr^{95}-Nb^{95}$ as oxalates in normal saline. After four days the animals were sacrificed by decapitation. Bones, muscles, liver, kidneys, gonads, heart, lungs, and spleen from each animal were dissected. Physical decay patterns of the nuclide pair were determined by standard γ-scintillation spectrometric methods. Bones accumulated the parent isotope preferentially, whereas blood retained the niobium-95 daughter. Therefore, results show that although zirconium and niobium are in the second transitional series and resemble each other in many of their physico-chemical properties, rat tissue

membranes show differential transport between Zr^{95} and Nb^{95}. (H.M.G.)

11605 UPTAKE OF IODINE-131 BY THE THYROIDS OF FEMALE MICE DURING THE OESTROUS CYCLE. F. A. Soliman, M. S. Abdo, M. K. Soliman, and M. F. Abdel Wahab (Univ. of Cairo and Atomic Energy Commission, Cairo). Nature, 201: 506-7(Feb. 1, 1964).

The I^{131} uptake by thyroid glands of female mice during the oestrous cycle is correlated with ovary histological appearance. (R.E.U.)

11606 TOXICOLOGY OF RADIATION, RADIOACTIVE ISOTOPES, AND FALLOUT. A. Heyndrickx (Rijksuniversiteit, Ghent). Pharm. Tijdschr. Belg., 37: 78-94(1960). (In Flemish)

A general review of radiation toxicology is presented. The units appropriate to the topic are defined and several of the reactions of water, fatty acids, and alcohols under the influence of ionizing radiation are listed. Radioprotective groups—cysteine, cysteamine, cystamine, glutathione—are discussed briefly, with a mention of the use of injections of marrow homogenates in exposed individuals. The nature of dangers from the use of nuclear energy is given briefly; some values of background radiation are tabulated. The analysis of radioactive isotopes remaining 25 days after explosion of an atomic bomb is given, and the analysis of radioactive material in autopsy material (various organs) 207 days after the explosion in Japan is tabulated. Acute toxicity and chronic poisoning effects are mentioned, especially of industrial radium poisoning. A relatively complete table of maximal permissible body dose and concentrations of various isotopes in air and water is given, and the use of EDTA, DTPA, and BAETA in decontamination is stated. The Los Alamos and Argonne-type determinations of natural radioactivity of individuals are discussed; decontamination methods for the skin, especially for removal of Pu, fission products, P^{32}, and for head hair, the hands, and wounds are stated explicitly, together with methods for increasing excretion of absorbed radioelements. A brief discussion of the explosions in Japan with respect to the effects of the different waves and pathological effects is given. Protection for workers with different isotopes in pharmacological use is listed as well as notes on the disposal of hospital wastes. Six general literature sources are given. (BBB)

11607 UPTAKE AND TRANSPORT OF RADIOCHLORIDE AND TRITIATED WATER BY VARIOUS ZONES OF ONION ROOTS OF DIFFERENT CHLORIDE STATUS. Thomas K. Hodges and Yoash Vaadia (Univ. of California, Davis). Plant Physiol., 39: 104-8(Jan. 1964).

The uptake and transport of radiochloride and tritiated water by different root zones of individual exuding onion (Allium cepa) roots of different chloride status was determined. The terminal 3 cm of the root was most active in Cl^{36} accumulation and transport to the exudate. The net rate of Cl^{36} accumulation by the root tissue initially decreased with time, whereas the rate of Cl^{36} transport to the exudate remained constant over a 12 hour period. It was suggested that the transport of ions into vacuoles also occurs at a constant rate which is accompanied by progressively increasing rates of ion efflux from vacuoles. The reoccupation of active transport sites by ions moving from vacuoles to cytoplasm would account for the decreasing rate of net accumulation with time and also the reduced uptake and transport of Cl^{36} in high chloride roots. Exudate concentrations of Cl^{36} exceeded tissue concentrations of Cl^{36} when tracer absorption occurred at the 3 to 6 cm zone of high chloride roots. This result was obtained even though water absorption from the 1 to 3 cm and 6 to 9 cm zones would have caused dilution of the xylem steam. Movement of Cl^{36} from the treated zones to untreated zones was negligible as was movement from the xylem into the untreated zones. The uptake and movement of tritiated water (THO) to root exudates was unaffected by the chloride status of the tissue. The 6 to 9 cm zone appeared to absorb THO most rapidly. Adjacent root zones had only a trace of THO. (auth)

11608 STRONTIUM DISTRIBUTION IN PLASMA AND THE POSSIBILITY OF CHANGING IT EXPERIMENTALLY. J. Vostal and D. Vlachova (Ustav Hygieny Práce Chorob Povolání, Prague). Pracovni Lekar., 14: 449-53(Dec. 1962). (In Czech)

Distribution of Sr, as free ionic and protein-bound fractions, in heparinized bovine plasma was studied by ultrafiltration experiments using Cellophane (Visking casing) membranes. The experiments were carried out at 37°C after addition of 2-16 mg/100 ml $SrCl_2$ to plasma. The effect of various concentrations of Ca on distribution of Sr was also studied. In the absence of added Ca, an average of 40% of Sr is bound to protein and 59.4 ± 1.23% is ultrafiltrable. If Sr is added to plasma as a chelated complex with lactic acid, citric acid, or ethylenediaminetetraacetic acid (EDTA) the proportion of filtrable Sr is increased significantly. Of the substances investigated, citric acid exerted the most marked effect on Sr concentration in the ultrafiltrate (increase up to 82.5 ± 0.93%), whereas the effects of lactic acid and EDTA were less pronounced (increases to 69.3 ± 0.82 and 66.3 ± 0.92%, respectively). The mechanism effecting the passage of Sr to the ultrafiltrate was considered. The stability of the bond between Sr and bovine plasma proteins is only slightly less than the avidity of the Ca linkage and 5-fold higher molar concentrations of Ca in plasma than Sr are required for a 10% increase in the filtrable proportion under the conditions investigated. It is suggested that the method of ultrafiltration used is suitable for testing still other possibilities for influencing the passage of Sr from plasma to urine. (BBB)

11609 CALCIUM, STRONTIUM, AND OSTEOGENESIS. J. F. Loutit (Medical Research Council Radiobiological Research Unit., Harwell, Berks, Eng.). Proc. Nutr. Soc. (Engl. Scot.), 22: 140-5(1963).

Accumulated information on Sr^{90} levels in the diet and in human bone, particularly in the British Isles, is considered, and its significance in Ca and Sr metabolism discussed. Full-term infants in the United Kingdom are born with approximately 28 g Ca and approximately 5.6 mg Sr in the skeleton. The Sr^{90}:Ca ratio varies according to the recent maternal diet, the contamination of which varies from year to year; its value is about $\frac{1}{10}$ of that of the maternal diet owing to discrimination between Sr and Ca by the mother in absorption, excretion, and transplacental passage. Maximal postnatal growth of the skeleton occurs in the first year of life and the discriminatory powers of such infants are less than those of adults. In the subsequent few years of life the observed values for Sr, Sr^{90}, and Ca suggest a very high rate of turnover of bone with a diminishing rate of accretion of new bone. In adolescence similar data suggest that accumulation of Sr^{90} is mainly due to accretion of new bone with diminishing turnover. Evidence of discrimination in transplacental passage was obtained from assays of bones of the newborn for natural Sr. The mean value for newborn infants was 207 μg/g Ca. For adult bone the value was 319 μg Sr/g Ca, which corresponds closely to the value obtained for human plasma 30 to 40 μg/l. The observed

ratio, (OR) (Sr/Ca fetal bone: Sr/Ca maternal plasma), of 207/319 = 0.6. A similar OR was derived from the data for Sr^{90} but with less certainty. Thus the bones of newborn in 1959 had average values in pC Sr^{90}/g Ca of 1.13. Maternal plasma values are too low for measurement, but if a representative OR human plasma + human diet of 0.25 be taken, and diet in 1959 averaged 9 pC/g Ca, the OR = 0.5. For the newborn, the Sr^{90} content varies with the year of birth (average 0.44, 0.61, 0.62, 1.13, 0.88, and 0.72 pC/g Ca in the 6 years 1956 to 1961). Stable Sr alters little in the first 6 months but rises significantly to about 245 μg/g Ca at 1 yr of age. The corresponding Sr^{90} figure again varies according to the year, the maximum value for the annual mean being in 1959 at 4.3 pC/g Ca. Specific activity and total Sr^{90} in the skeleton rose in the first year, when the proportionate accretion of new bone is maximal. The British diet and milk over this period contained 5 to 6 pC/g Ca, and, if 0.5 mg Sr/g Ca be assumed, this gives a specific activity of diet of approximately 11 pC/mg Sr, which is higher than the value deduced for bone (8.6). In the second year, when diet was more contaminated (national diet, 9.0 pC/g Ca) and diet of 1- and 2-yr olds was 14 pC/mg Sr, and accretion of new bone reduced to 50% of the pre-existing skeleton, the specific activity of bone rose with diet to 12.6 pC/mg Sr. For the third year (diet reduced as 9 pC/mg Sr) the specific acitivity of bone was 10.5 pC/mg Sr. For the fourth year with diet containing 8 pC/mg Sr, the value for bone was 6.8 pC/mg Sr. Thus, in these years the specific activity of bone followed that of the contemporary diet very closely. By contrast, the data similarly obtained for a representative adolescent in 1954, at the age of 7 would have had a skeleton of 264 g Ca virtually free of Sr^{90}. He would then enter the second burst of growth around the years of puberty, and show a progressive rise in specific and total activity of the skeleton from 1956 to 1961. The data are largely accounted for by accretion of new bone with specific activity corresponding to the national diet in these years (estimated as about 4 pC/mg Sr in 1956 and 1957, and as 4.5, 6.9, 4.9, and 4.8 in the subsequent years). During this 5-yr period the skeletal Ca was doubled, but the specific activity (Sr^{90}/mg Sr) at the end of the period was still well below that of the diet. (BBB)

11610 EFFECTS OF HYDROBIOTITES UPON STRONTIUM-89 AND CESIUM-137 RETENTION BY RUMINANT ANIMALS. Sam L. Hansard (Louisiana Agricultural Experiment Station, Baton Rouge). Proc. Soc. Exptl. Biol. Med., 115: 346-50(Feb. 1964).

Radiochemical studies with ruminant animals indicate that activated verxites, a nearly pure hydrobiotite, effectively bind Sr-89 and Cs-137 in vitro and in vivo, thus increasing excretion rate and quantity of these radionuclides injected or ingested at tracer levels. (auth)

11611 EFFECT OF FLUORIDE ON CRYSTAL TEXTURE AND RADIOCALCIUM UPTAKE OF RAT BONE. R. C. Likins, A. S. Posner, and G. Pakis (National Inst. of Dental Research, Bethesda, Md.). Proc. Soc. Exptl. Biol. Med., 115: 511-13(Feb. 1964).

Uptake of Ca^{45} and hydroxyapatite crystallinity as measured by degree of resolution of its x-ray diffraction pattern was compared in the femur, vertebra, and alveolar bone of rats given a drinking water containing either no fluoride or 50 ppm F for 14 months. Vertebra and alveolar bone contained significantly more Ca^{45} than femur. Fluoride administration improved bone crystallinity but did not affect radiocalcium uptake. The possible effect of fluoride in bone accretion is discussed in relation to the above findings. (auth)

11612 OXIDATIVE PHOSPHORYLATION AND THE SERUM PROTEIN ELECTROPHORETIC PATTERN OF RATS TREATED WITH HOMOLOGOUS SERA OF IRRADIATED ANIMALS. Paolo Erede, Franca Duerst, and Pietro Bistolfi (Università, Genoa). Riv. Biol., 54: 519-30(Oct.-Dec. 1961). (In Italian)

Changes in oxidative phosphorylation and the morphology of mitochondria in the liver and kidney of rats injected with homologous serum of irradiated animals were studied to see if such serums would cause pathological alterations in the organs. Experiments were conducted in Wistar rats, weighing 120–180 g, fed on a standard diet. The rats were killed by decapitation and the organs (liver and kidney) were immediately dissected, weighed, and transferred to the cold room at 2°. Homogenization was carried out in a Potter-Elvehjem apparatus, 10% homogenates being prepared in 0.25 M sucrose. Tissue debris, whole cells, nuclei, and some mitochondria were discarded by centrifugation at 1500 g for 5 min; mitochondria were sedimented at 12000 g for 20 min. It was found that the homologous serum of irradiated rats administered to normal rats by peritoneal injection caused cellular damage (decrease in the phosphorylation/oxidation ratio and swelling of mitochondria); on the contrary, it did not induce uncoupling of oxidative phosphorylation in vitro. No changes were noted in the protein levels in serum belonging to rats treated with homologous serums of normal and irradiated animals. In the serum of irradiated rats the albumins were decreased and α_1- and β-globulins were increased. (TCO)

11613 THE TOXICOLOGY OF RADIOACTIVE SUBSTANCES. VOLUME I. STRONTIUM, CAESIUM, RUTHENIUM, RADON. A. A. Letavet and E. B. Kurlyandskaya. Translation edited by E. Lloyd. Oxford, Pergamon Press, 1962. 236p.

11614 THE PREPARATION, DISTRIBUTION AND METABOLISM OF H^3–VITAMINS D_2 AND D_3. Anthony Westcott Norman. Thesis, Madison, Wis., Univ. of Wisconsin, 1963. 186p.

A convenient and inexpensive procedure for the preparation of tritium-labeled vitamin D_2 and D_3 is described. The provitamins were exposed to tritium gas by the procedure of Wilzbach, purified by several recrystallizations, and irradiated with ultraviolet light. The resulting H^3–vitamins D_2 and D_3 were obtained after 3 recrystallizations of the 3,5-dinitrobenzoate esters. The H^3–vitamins D_2 and D_3 (both the 3,5-dinitrobenzoate esters and the unesterified H^3–vitamins D_2 and D_3) were at least 99% radiochemically pure in 4 chromatographic systems and were fully biologically active. Two new systems for the chromatography of vitamin D and other compounds produced by ultraviolet irradiation of ergosterol and 7-dehydrocholesterol were devised. The distribution of a physiological dose of H^3–vitamin D_3 as a function of time was studied in various rat tissues. Evidence is presented for the involvement of the ileum in the absorption of vitamin D. The liver rapidly accumulated the largest amount of radioactivity, whether the dose was administered orally or intracardially. Tissues normally associated with vitamin D action accumulated a significant portion of the administered dose retained by the animal. Virtually no radioactivity was detected in the adrenals. Examination of the subcellular location of radioactivity in the kidneys, liver, and intestinal mucosa after an oral dose of 500 i.u. of H^3–vitamin D_3 was accomplished by conventional cell fractionation techniques. Studies were

made to determine the chemical form of the radioactivity present in the kidney 24 hrs after an oral dose of 500 i.u. of H^3–vitamin D_3. At least 80 to 90% of the radioactivity moved identically with vitamin D in the chromatography systems and had full biological activity when assayed in the rat. The other 10 to 20% of radioactivity was only 30–50% as active as a standard vitamin D sample. It appears that, in the kidney, vitamin D is not metabolized in large amounts to other fully biologically active compounds and that vitamin D may have a generalized distribution in all membrane systems. (M.P.G.)

11615 THE TRANSFER OF CALCIUM AND STRONTIUM ACROSS BIOLOGICAL MEMBRANES. Proceedings of a Conference Held at Cornell University, Ithaca, New York, May 13-16, 1962. R. H. Wasserman, ed., (Cornell Univ., Ithaca, New York). New York, Academic Press, 1963. 457p.

Separate abstracts were prepared on 7 papers. One paper was previously abstracted and appeared in NSA. Fourteen papers cover other aspects of Ca and Sr transport across biological membranes. (C.H.)

For abstracts of individual papers see: 11616, 11617, 11618, 11619, 11620, 11621, and 12402.

11616 BIOLOGICAL IMPLICATIONS OF ALKALINE EARTH CHELATION. Martin Rubin (Georgetown Univ., Washington, D. C.). p.25-46 of "The Transfer of Calcium and Strontium Across Biological Membranes." New York, Academic Press, 1963.

Theories of ion transport across biological membranes that would provide grounds for the concentration of alkaline earths in living systems are reviewed. The concept of chelation is considered with emphasis on alkaline earth bonding. Topics discussed include factors involved in chelate stability, chelate buffer systems, the effect of hydrogen ion concentration on chelation, and the effect of ligand concentration on metal binding. Applications of chelation in studies of Ca metabolism in mammals, using EDTA as an alkaline earth binding chelate, are reviewed. (C.H.)

11617 OVER-ALL ASPECTS OF CALCIUM AND STRONTIUM ABSORPTION. F. W. Lengemann (Cornell Univ., Ithaca, N. Y.). p.85-96 of "The Transfer of Calcium and Strontium Across Biological Membranes." New York, Academic Press, 1963.

Experiments with rats suggest that the ileum is the segment of the small intestine that has the slowest rate of absorption; however, the movement of ingesta through this segment is so slow as to render the ileum the most important segment for absorption of Ca and Sr. Absorption of these elements from the digestive tract is normally an inefficient process though dietary additives or physiological circumstances can increase the amount passing into the body. Under the condition of increased absorption it has been noted that the degree of differentiation between Sr and Ca by a particular segment of the small intestine is often reduced. The observation that the proportion of Sr and Ca absorbed, relative to the total absorption of each ion, is equal within each segment of the small intestine suggests that some limits can be set for the absorption mechanism that is responsible for the movement of Sr and Ca into the body. For a postulated mechanism to be of consequence in the normal nutrition of an animal, it must be operative throughout the small intestine, in all sections even though the dietary history of the animal is one of high Ca feeding, and in such a way as to favor Ca absorption over that of Sr. (auth)

11618 VITAMIN D AND THE ABSORPTION OF CALCIUM AND STRONTIUM IN VIVO. R. H. Wasserman (Cornell Univ., Ithaca, N. Y.). p.211-28 of "The Transfer of Calcium and Strontium Across Biological Membranes." New York, Academic Press, 1963.

Studies were undertaken to determine the mechanism of action of vitamin D on increasing the intestinal absorption of Ca in the rachitic chick. Results showed that the vitamin D effect occurs in all segments of the chick intestine with the greatest degree of absorption occurring in the duodenum and jejunum; the vitamin D-mediated effect was not specific for Ca and was shared by Be^{++}, Mg^{++}, Sr^{++}, Ba^{++}, Zn^{++}, Co^{++}, Cd^{++}, and Cs^{+}; vitamin D increased the bidirectional flux of Ca across the chick duodenum although the efflux/influx ratio of Ca was not significantly influenced by vitamin D; vitamin D enhanced the in vivo mucosal uptake of Mg^{++}, Ca^{++}, Sr^{++}, and Ba^{++} from the lumen; vitamin D did not alter the uptake of plasma Ca^{++} by the mucosal tissue but did enhance the transfer rate from mucosal cell to lumen; the effect of hydrocortisone on these processes and other data suggested an effect of vitamin D on two processes: Ca^{++} transfer across the luminal surface of the mucosal cell and on Ca^{++} turnover within the cell; the in vitro studies indicated that the following agents did not inhibit the vitamin D effect: N_2 atmosphere, depressed temperature, NaCN, dinitrophenol, ouabain, BAL, saponin, and dicoumarol. The absence of inhibition may be due to little or no penetration to sensitive sites. In view of these data, three possible mechanisms were proposed. (auth)

11619 LACTOSE AND THE ABSORPTION OF CALCIUM AND STRONTIUM. Y. Dupuis and P. Fournier (National Center of Scientific Research, Paris). p.277-93 of "The Transfer of Calcium and Strontium Across Biological Membranes." New York, Academic Press, 1963.

Under physiological conditions, lactose introduced in the nutrition of the rat stimulates Ca absorption and, above all, permits its utilization, i.e., it assures a normal Ca level and permits normal ossification. Lactose appears to be an indispensable exogenous factor. Numerous substances, generally carbohydrates, grouped under the term of structural compounds have the same effect when introduced in the diet. Experimentally, it was demonstrated that the effect of lactose is realized in a particular region of the digestive tract, the ileum, provided that Ca is simultaneously present in the same place. Similar experiments proved that energetic sugars have a similar effect on the utilization of Ca, but, owing to their absence as a result of their rapid absorption, the latter cannot act under natural conditions. The fact that lactose, energetic carbohydrates, and other different compounds called structural, whether or not they can be found in nature, can play this same role of indispensable exogenous factor in Ca utilization gives good evidence of the nonspecificity of this effect. The physiological worth of lactose remains unchallenged. (auth)

11620 RENAL EXCRETION AND TUBULAR REABSORPTION OF CALCIUM AND STRONTIUM. Mackenzie Walser and Brian H. B. Robinson (Johns Hopkins Univ., Baltimore). p.305-26 of "The Transfer of Calcium and Strontium Across Biological Membranes." New York, Academic Press, 1963.

Current evidence concerning the physicochemical state of Ca and Sr in plasma is reviewed. Among the factors which affect Ca and Sr excretion by the kidney, three are examined in detail, the Na clearance, the rate of excretion of anions which complex Ca and Sr, and the level of adrenocortical activity. (auth)

11621 STUDIES ON THE MOVEMENT OF CALCIUM AND STRONTIUM ACROSS THE BOVINE MAMMARY GLAND. A. R. Twardock (Cornell Univ., Ithaca, N. Y.). p.327-39 of "The Transfer of Calcium and Strontium Across Biological Membranes." New York, Academic Press, 1963.

It is obvious that our knowledge of the physiology of Ca secretion into milk has not advanced significantly in recent years, and the question of active Ca transport in the mammary gland remains open. Protein binding of Sr in blood serum and milk does result in a concentration ratio of 5 to 6 in favor of milk, which is the ratio that is usually observed in milk from the lactating animal. Protein binding of Ca, however, does not produce the milk-serum Ca ratio observed in the lactating animal. The citrate ion deserves attention in this regard, because of its high concentration in milk with respect to blood, and its greater affinity for Ca than for Sr. Different experimental approaches must be used if significant new information about mammary Ca secretion and mammary Ca–Sr discrimination is to be obtained. These are obvious limits to the use of intravenous infusions into lactating animals. Two approaches that might be investigated are: perfusion of the udder in vitro, and the use of mammary tissue slices. Udder perfusions were not attempted because of lack of time and the specialized skills required to successfully carry out this technique. The question as to whether or not true milk synthesis and secretion actually take place during the perfusion process has served as an additional deterrent. Preliminary experiments on the uptake and release of Ca^{45} and Sr^{85} by lactating mammary tissue slices from rats were carried out. The major problem with this procedure is distinguishing the effects of physical binding by tissue components and residual milk from the effects on uptake and release by metabolic processes. (auth)

11622 KINETIC THEORY: SOME ASPECTS ON THE STUDY OF METABOLIC PROCESSES. Per-Erik E. Bergner (Karolinska Institutet, Stockholm). 23p. (CONF-355-3).

From Symposium in Medicine, Dynamic Clinical Studies with Radioisotopes, Oak Ridge, Tenn., Oct. 1963.

Biological models are described that were developed for use in kinetic studies of metabolic processes. Applications in tracer studies are reported. (C.H.)

Radiation Effects

11623 (AD-407411) STUDIES ON PHYSICAL AND CHEMICAL MODIFICATION OF PROTEINS FOR THE PREVENTION OF IRRADIATION OFF-FLAVORS IN MEAT. Report No. 16 (Final), May 15, 1958–September 14, 1962. A. L. Tappel (California. Univ., Davis). Contract DA19-129-QM-1172. 34p.

Radiation damage to ovalbumin, hemoglobin, and cytochrome c was studied under anaerobic condition and the degradation mechanisms are discussed. The radiolability of free amino acids was determined and evaluation methods for the radiolability are discussed. The radiolability of amino acids as free amino acids or bound in peptide linkage in protein is also discussed. The radiolability of methionine and its derivatives were studied and the degradation mechanisms are discussed. Decrease of radiation damage to ovalbumin, hemoglobin, and cytochrome c by cystine, AET, and MEA was studied and their protection mechanisms are discussed. Decrease of radiation damage to some of the typical amino acids by methionine was also studied and their mechanisms are discussed. (auth)

11624 (AD-407916) TOLERANCE OF MICE X IRRADIATED IN AN OXYGEN-RICH ENVIRONMENT TO THE STRESS OF EXPLOSIVE DECOMPRESSION. Report No. 4. Donald E. Furry (Naval School of Aviation Medicine, Pensacola, Fla.). Feb. 25, 1963. 7p.

Male Swiss albino mice exposed to 700 r whole-body x irradiation while breathing either air or 100% oxygen were explosively decompressed from sea level to a terminal altitude of 30,000 ft. A second group of mice exposed to x irradiation only while in an air or O-rich environment were maintained for a 30-day observation period. On the basis of pooled survival data it was concluded that the use of either an air or O-rich environment during exposure to x irradiation has no effect on the tolerance of mice to explosive decompression as evidenced by immediate survival or 30-day survival. The expected 30-day survival proportion of mice exposed to whole-body x irradiation only while breathing O was significantly reduced when compared to the survival proportion of mice breathing air. (auth)

11625 (AD-409165) A STUDY OF FLAVOR OF IRRADIATED MEAT. Report No. 8 (Final), January 14, 1961–January 13, 1963. (Battelle Memorial Inst., Columbus, Ohio). Contract DA-19-129-QM-1734. 34p.

Preliminary results are reported from a study of factors affecting the flavor of irradiated meat. Methods were selected for sample preparation, sensory panel presentation, and sensory panel evaluation. A study was made of chemical compounds identified in the volatiles of irradiated beef and their contribution to the odor of radiation-processed beef. (C.H.)

11626 (AD-409876) STUDY OF FREE RADICALS IN IRRADIATED BEEF. Report No. 7 (Final), December 30, 1960–December 29, 1962. W. H. Storey, Jr. (Southwest Research Inst., San Antonio). Contract DA19-129-QM-1740. 75p.

An investigation was made of mechanisms involved in the development of unsavory odors in cooked beef during radiation processing. The odor is described as resembling that of wet dog hair. Electron spin resonance data were analyzed in an attempt to establish a relation between radio-induced free radicals in beef and the odor. Data are reported from studies on nondialyzable fractions of aqueous extract of cooked beef. Procedures used for sample preparation prior to exposure to a Co^{60} γ source, ESR instrumentation, and odor analysis are described. Results suggest that glycine and methionine units in the protein, either bonded to one another or as close neighbors, are involved in the odor production through a reaction involving a radio-induced free radical and water. (C.H.)

11627 (CONF-81-5) BASIC MECHANISMS IN THE RADIATION CHEMISTRY OF PROTEINS AND NUCLEIC ACIDS. Robert A. Luse (Puerto Rico Nuclear Center, [Mayagüez]). [1963]. Contract [AT(40-1)-1833]. 33p.

From Conference on Basic Mechanisms in the Radiation Chemistry of Aqueous Media, Gatlinburg, Tenn., May 1963.

Basic mechanisms involved in the radiation chemistry of proteins and nucleic acids are discussed. Various hypotheses that have been proposed to explain quantitatively the effects of ionizing radiations on simple biological systems are reviewed, with emphasis on the hit and target theories and the hypothesis of diffusing agents or indirect action. Data are summarized from a number of studies on the radiosensitivity of enzymes and nucleic acids. It is concluded that any particular mechanism proposed for enzymes and nucleic acids will give only a part of the

radiobiological effect in a living cell and that the structural organization of the cell overrides any proposal in which one mechanism operating for one cellular component is considered the one effect of radiation in the cell. (C.H.)

11628 (IDO-11300) CURRENT STATUS AND POTENTIAL OF IRRADIATION TO PREVENT POTATO SPROUTING. George A. Freund (Western Nuclear Corp., Idaho Falls, Idaho). Jan. 1964. Contract AT(10-1)-1167. 84p.

Potato production and processing methods in the U. S. and Canada are reviewed. The current status and cost of radiation processing to prevent sprouting during storage are discussed. It is concluded that, under present market conditions, widespread use of irradiation as a sprout inhibitor is not feasible. (C.H.)

11629 (NADC-MA-6315) THE EFFECT OF WHOLE-BODY X IRRADIATION ON THE FREE AMINO ACID COMPOSITION OF RAT BRAIN AS DETERMINED BY ION EXCHANGE CHROMATOGRAPHY. Report No. 20. Herman W. Shmukler and B. David Polis (Naval Air Development Center. Aviation Medical Acceleration Lab., Johnsville, Penna.). Aug. 30, 1963. 12p.

The effects of whole-body x irradiation on the nonprotein amino acids and related compounds of rat brains were determined by automatic ion exchange chromatography. Significant decreases were found in the brain levels of taurine, urea, serine, glutamine, alanine, methionine, β-alanine, and arginine, while ethanolamine-ammonia was the only chromatographic peak which showed a significant increase. Comparison of these results with the changes previously reported as a result of acceleration stress suggest that the decrease in the serine and urea content and the increase in the ethanolamine-ammonia complex reflect the effects of a generalized stress syndrome. (auth)

11630 (NP-13555(p.1-14)) THE EFFECTS OF IONIZING RADIATIONS ON THE BIOCHEMISTRY OF MAMMALIAN TISSUES. I. INFLUENCE OF X IRRADIATION ON THE DEVELOPMENT OF A THIOPHOSPHATE-OXIDIZING ENZYME SYSTEM IN THE LIVERS OF MALE RATS. Bernard E. Hietbrink and Marjorie Keshmiri (Chicago. Univ. Air Force Radiation Lab.).

Studies were undertaken to obtain additional information concerning the mechanisms involved in the inhibitory effect of ionizing radiations on the development of the phosphorothioate-oxidizing enzyme system in the livers of young male rats. The results of experiments on the influence of partial body shielding on the development of enzyme activity indicated that shielding the liver and testes area did not substantially reduce the degree of inhibition caused by 200 r of total-body x irradiation. It was found that the administration of 200 r of x ray to the head of a 23-day-old male rat causes a marked inhibition in the development of the phosphorothioate-oxidizing enzyme which is reversible during the fourth week following radiation and reaches approximately adult levels at five weeks after exposure. Administration of 0.1 ml/day of adrenal cortex extract provided a substantial reduction in the inhibitory effect on the development of microsome oxidase activity caused by 200 r of x-ray to the head area. Daily injections of 0.1 mgm of thyroxine failed to reduce the inhibitory effect of radiation on the synthesis of microsomal enzymes caused by 200 r. The effect of 200 r of total-body x irradiation given at 27 and 30 days of age on the development of microsome oxidase activity was tested. It was shown that this dose of radiation given at 27 or 30 days of age was less effective in inhibiting the development of enzyme activity than when given at the time the animals were 23 days old. (auth)

11631 (NP-13555(p.15-33)) THE EFFECTS OF IONIZING RADIATIONS ON THE BIOCHEMISTRY OF MAMMALIAN TISSUES. II. INFLUENCE OF VARIOUS FACTORS ON RADIATION-INDUCED INHIBITION OF THE DEVELOPMENT OF DETOXIFICATION ENZYMES. Kenneth P. Dubois and Florence Kinoshita (Chicago. Univ. Air Force Radiation Lab.).

The development of resistance by weanling male rats to the toxicity of O,O-diethyl-O-(methylthio-m-tolyl) phosphorothioate (DMP) was studied by administering various doses of the compound from 23 to 53 days of age and measuring the amount of inhibition of brain cholinesterase activity. It was found that marked resistance was acquired within the relatively short period between 37 and 42 days of age. To study the effects of irradiation on the development of resistance to DMP, young male rats were exposed to 200 r or 400 r and various doses of DMP were given at intervals following irradiation. By comparison of the amount of inhibition of cholinesterase produced by the compounds in the irradiated animals with the amount produced in normal animals of the same age, it was possible to obtain an indication of the inhibition of the development of resistance by radiation. In animals irradiated at 23 days of age and sacrificed at 37, 38, 42, and 54 days of age, DMP produced much more inhibition of cholinesterase than was produced by the same doses in normal animals. The LD_{50} of DMP to normal 40-day-old rats was 124 mg/kg and the value for rats of the same age that were exposed to 400 r of x ray at 23 days of age was 10.3 mg/kg thus demonstrating the marked effect of radiation on the development of resistance. Measurements of the effect of puromycin given in a single dose of 35 mg/kg on the development of resistance to DMP in young male rats demonstrated that it does not inhibit the development of the detoxification system. However, actinomycin (0.4 mg/kg) given at 31 days of age inhibits development of the detoxification system. Exposure of rats to 800 r of x ray had no effect on induction of the detoxification system caused by phenobarbital. Daily administration of testosterone, methyltestosterone, progesterone, and diethylstilbestrol to adult female rats had produced a gradual increase in development of resistance to DMP and this effect was not inhibited by previous exposure to 400 r x radiation. (auth)

11632 (NP-13555(p.107-17)) THE INFLUENCE OF EXPOSURE TO LOW LEVELS OF GAMMA AND FAST NEUTRON IRRADIATION ON THE LIFE SPAN OF ANIMALS. I. CURRENT STATUS OF THE CHRONIC LOW LEVEL FAST NEUTRON IRRADIATION PROGRAM. A. Sandberg and J. Doull (Chicago. Univ. Air Force Radiation Lab.).

Mortality data obtained during the first 80 weeks of a duration-of-life chronic fast neutron irradiation study are presented and compared with results of previous studies. The median survival time of mice exposed to 3.18 rad/day was 32 weeks, for those exposed to 0.47 rad/day was 56 weeks, and for those exposed to 0.36 rad/day was 59 weeks. The median survival time of the control animals was 67 weeks. The accumulation of survival data to date indicates that the life-span shortening effects of chronic low level neutron irradiation as a function of the daily neutron dose is a curvilinear response. Preliminary investigations involving the possibility of using the viscosity of salt solution extracts of skin collagen have indicated that although a decrease does occur with aging,

no additional decrease occurs with chronic neutron irradiation and this effect is at least probably in part growth-rate dependent. (auth)

11633 (NP-13574) TO DETERMINE THE EFFECT OF IRRADIATION UPON THE WHOLESOMENESS OF FOOD. Progress Report No. 12, March 1961–September 1961. Om P. Malhotra, Elwood F. Reber, and Horace W. Norton (Illinois. Univ., Urbana. Coll. of Veterinary Medicine). Contract DA-49-007-MD-72800. 11p.

Orchiectomized rats were fed a diet containing irradiated beef for 15 weeks. The diet was supplemented with 0, 0.69, 1.37, or 2.06% methionine and the rats received injections of 0, 0.06, 0.3, or 1.5 μg of estrogen 3 times a week. Blood samples were obtained from all rats periodically for the determination of prothrombin times. Data are presented on the effects of diet, methionine, and estrogen on the incidence of hemorrhagic disease, prothrombin time, and growth rate. The beef was irradiated with 5.58 or 2.79 megarad radiation. (C.H.)

11634 (NP-13575) RADIOISOTOPES IN RADIATION PROCESSED FOOD. Semi-annual report, September 15, 1963. George R. Meneely (Northwestern Univ., Chicago. Medical School). Contract DA-49-193-MD-2315. 17p.

Beta activity due to P^{33}, S^{35}, Ca^{45}, and Sr^{90} was searched for but could not be detected in any of 18 food samples whether irradiated or nonirradiated. The foods included pork, ham, beef, chicken, and bacon exposed to Co^{60} γ radiation or electrons of energies up to 11.2 Mev. Gamma activity in the same foods and two additional foods exposed to 8.4-Mev electrons had the same spectra as unirradiated food samples. The significance of the findings is discussed. (C.H.)

11635 (NP-13576) PEACHES, ORANGES—REPORT ON OBSERVATIONS ON NUTRITION: RADIATION AND STERILIZATION OF FOODS FOR VANDERBILT UNIVERSITY, NASHVILLE, TENNESSEE. M. A. Ross (Armed Forces Inst. of Pathology, Washington, D. C.). Sept. 15, 1963. 8p.

No evidence could be found to suggest that the consumption of irradiated peaches, whole oranges, or peeled oranges, irradiated at two levels, was responsible for the incidence of lesions noted in monkeys. The lesions observed were those commonly seen in monkeys and were of no significance insofar as the experimental procedure was concerned. (auth)

11636 (NP-13577) TO DETERMINE THE EFFECT OF IRRADIATION UPON THE WHOLESOMENESS OF FOOD. Progress Report No. 16, March 1963–September 1963. Elwood F. Reber (Illinois. Univ., Urbana. Coll. of Veterinary Medicine and Illinois. Agricultural Experiment Station, Urbana). Contract DA-49-007-MD-72800. 28p.

Progress is reported in the development of a method for producing commercially sterile hams in small cans by a combination of mild heat treatment and a pasteurizing dose of ionizing radiation. A method is described for determining the dose distribution in cans irradiated in a linear accelerator. Irradiated beef as a source of amino acids was evaluated in a series of studies in rats fed a diet containing irradiated beef, irradiated beef plus amino acid supplements, or nonirradiated beef plus amino acid supplements. The groups fed nonirradiated beef and amino acid supplements responded with the best growth rate. (C.H.)

11637 (NP-13578) IRRADIATED CHICKEN STEW AND CABBAGE DIET—REPORT OF OBSERVATIONS [ON] NUTRITION, RADIATION AND STERILIZATION OF FOODS FOR BIOLOGICAL RESEARCH LABORATORIES, SYRACUSE UNIVERSITY RESEARCH INSTITUTE, SYRACUSE, NEW YORK. F. M. Garner (Armed Forces Inst. of Pathology, Washington, D. C.). Sept. 15, 1963. 25p.

A histologic review of autopsy material from rats maintained on a diet containing irradiated chicken stew and cabbage showed no effects attributable to diet. The food was exposed to 2.79 or 5.58 megarads radiation. (C.H.)

11638 (NP-13579) JAM DIET—REPORT OF OBSERVATIONS ON NUTRITION: RADIATION AND STERILIZATION OF FOODS FOR OREGON STATE UNIVERSITY, CORVALLIS, OREGON. M. A. Ross (Armed Forces Inst. of Pathology, Washington, D. C.). Sept. 15, 1963. 22p.

The consumption of irradiated jam for a two-year period caused no specific histologic changes in rats. The jam was irradiated at levels of 2.79 or 5.58 megarads. (C.H.)

11639 (NP-13580) EVAPORATED MILK—REPORT OF OBSERVATIONS ON NUTRITION: RADIATION AND STERILIZATION OF FOODS FOR UNIVERSITY OF MIAMI, CORAL GABLES, FLORIDA. M. A. Ross (Armed Forces Inst. of Pathology, Washington, D. C.). Sept. 15, 1963. 35p.

No pathological conditions associated with diet were observed following histologic review of autopsy material from 150 rats maintained for a period of two years on a diet containing irradiated evaporated milk. The milk was processed by exposure to 2.79- or 5.58-megarad radiation. (C.H.)

11640 (NP-13581) CODFISH AND SWEET POTATO—REPORT OF OBSERVATIONS ON NUTRITION: RADIATION AND STERILIZATION OF FOODS FOR AUBURN UNIVERSITY, AUBURN, ALABAMA. M. A. Ross (Armed Forces Inst. of Pathology, Washington, D. C.). Sept. 15, 1963. 28p.

A histologic review of autopsy material from rats maintained for 2 yr on a diet containing irradiated codfish and sweet potatoes showed no effects attributable to diet. (C.H.)

11641 (NP-13582) CORN AND TUNA DIET—REPORT OF OBSERVATIONS ON NUTRITION: RADIATION AND STERILIZATION OF FOODS FOR HAZELTON LABORATORIES, FALLS CHURCH, VIRGINIA. M. A. Ross (Armed Forces Inst. of Pathology, Washington, D. C.). Sept. 15, 1963. 16p.

No evidence was found to suggest that the consumption of irradiated corn or tuna fish produced lesions in rats significantly different in incidence or type than was found in animals that consumed the unirradiated products. (C.H.)

11642 (NP-13583) CAROTENE BIOPOTENCY IN RATIONS CONTAINING GAMMA-IRRADIATED CARROTS AND LIVER CYTOCHROME OXIDASE AND INGESTION OF IRRADIATED MEAT. Report No. 4, March 1, 1963–September 15, 1963. Ian J. Tinsley (Oregon. Agricultural Experiment Station, Corvallis and Oregon State Univ., Corvallis). Contract DA-MD-49-193-62-G42. 6p.

No decrease in growth rate of rats was observed as a result of a diet containing irradiated carrots stored for 6 months before feeding. Data are included from measurements of the fatty acid content of mitochondrial lipids of rats maintained on diets containing varying amounts of oleic acid. (C.H.)

11643 (NP-13584) FEEDING OF DOGS, RABBITS AND HAMSTERS WITH IRRADIATED SHRIMP AND ITS

EFFECT UPON THYROID ACTIVITY, (PHASE 1). EFFECT ON RESISTANCE TO INFECTION (PHASE 2). Progress Report No. 11, Six Months Period Ending September 15, 1963. D. F. Watson, K. G. Libke, R. M. Smibert, and R. W. Engel (Virginia. Agricultural Experiment Station, Blacksburg). Contract DA-49-007-MD-784. 18p.

Preliminary data are presented from studies on the inclusion of irradiated shrimp in the diet of dogs and rats. Data are included on thyroid lesions in 102 miscellaneous dogs on normal diets. Measurements were made of protein-bound iodine in the serum of normal rats and rats and dogs maintained on a diet containing irradiated shrimp. (C.H.)

11644 (NP-13600) INJURIOUS EFFECTS OF RADIATION ON THE EYE. (London. Royal Cancer Hospital. Inst. of Cancer Research). 1961. 16p.

One hundred forty references are presented to pertinent literature on the injurious effects of radiation on eyes and the induction of cataracts by irradiation. (C.H.)

11645 (ORO-614) SEMI-ANNUAL PROGRESS REPORT [ON UT-AEC AGRICULTURAL RESEARCH], JANUARY 1–JUNE 30, 1963. (Tennessee. Univ., Oak Ridge. UT-AEC Agricultural Research Lab.). Contract AT(40-1)-Gen-242. 120p.

One cow is reported surviving from the group of cattle exposed to radioactive fallout from the first atomic test at Alamogordo, N. Mex., in July 1945. The cow recently gave birth to a normal, healthy calf, which is the 15th calf in as many years. The status is reported for burros and swine surviving high-level, whole-body exposure to γ radiation, neutrons, or mixed γ and neutron irradiation. Data are included on the effects of exposure to 500 r γ radiation on spinal fluid pressure and the composition of cerebrospinal fluid in sheep. Research was continued on the effects of radiation on the reproductive cycle in cattle, sheep, swine, and rabbits. The death patterns of irradiated animals were related to examination of necropsies. Mammary tumor incidence in newborn female rats was found to be increased when they were injected with blood plasma concentrate from lethally irradiated donors. No significant increase was seen when rats were injected at six months of age. Data are presented from a study of fission product metabolism in beef cattle, sheep, swine, and poultry. Strontium-89, Sr^{89}, Ca^{45}, Zn^{65}, Mo^{99}, Ce^{144}, Pr^{144}, Se^{75}, and Co^{60} were used as tracers in the studies. Emphasis was placed on comparative information between species and the interaction of known dietary factors in the species. Factors affecting the I^{131} content in milk were also studied in dairy cattle. A study of the fission product chemistry of soils was continued to determine the soil properties that affect the availability of fission product elements to plant roots and the factors that can alter this quantitatively. Samples of dry and stratified seeds, dormant plants, and fungi growing on agar were irradiated. Results are presented from studies of factors that affect the radiosensitivity of seeds and other plant parts that can be used by plant breeders to increase the variability of plants. (C.H.)

11646 (TID-13635) MATHEMATICAL MODELLING FOR THE MORTALITY EFFECTS OF VARIOUS RADIATION DOSAGE SCHEDULES. Third and Final Report. A. S. Iberall (RAND Development Corp., Cleveland). Feb. 1964. Contract AT(11-1)-1254. 51p.

A mathematical model was developed for the mortality effects of various radiation dosage schedules. Lethality data on mice and rats exposed to ionizing radiation dosages from a variety of sources were combined to establish mortality and mortality rate contours. The data were used to review the mortality curves previously established. A broad modeling of the lethality effects of all types of radiation dosage schedules was developed. (C.H.)

11647 (TID-18285) LOW-LEVEL RADIATION PRESERVATION OF FISHERY PRODUCTS, OCTOBER 1960–OCTOBER 1962. Joseph W. Slavin, Maynard A. Steinberg, and Thomas J. Connors (Fish and Wildlife Service. Technological Lab., Gloucester, Mass.). Apr. 1963. Contract AT(49-11)-1889. 42p.

Shucked clam meats can be held at 33°F for about five days. When a dose of 50,000 rads was applied to air-packed clams, the shelf life at that temperature was approximately doubled; that is, spoilage occurred at about the tenth day of storage at 33°F. A dose of 150,000 rads increased the shelf life by about three times. At a level of 350,000 rads there was approximately a fourfold increase in storage life. After application of 450,000 rads, clam meats could be kept for at least 30 days at 33°F. At 42°F unirradiated clam meats have a probable shelf life of about two days. Radiation at any level up to 350,000 rads extends this time to more than ten days. Doses of 450,000 or 550,000 rads increase the holding time to more than 20 days before spoilage occurs. Vacuum-packed irradiated clams have the same storage properties as air-packed clams. At 32 to 33°F haddock can be kept for about 11 to 12 days before spoilage occurs. Irradiation of air-packed haddock at a level of 50,000 rads resulted in a response greatly different from that of clams. Instead of a doubling of the storage life, an increase of about only one-third was found. Spoilage occurred at about the twentieth day of storage. Radiation levels of 150,000 to 350,000 rads resulted in increasing storage life to at least 30 days at 33°F. At a storage temperature of 42°F air-packed haddock irradiated at 50,000 rads spoiled after 10 days of storage. At levels between 150,000 and 300,000 rads the fillets could be kept for at least 30 days. Packing the fillets under vacuum did not change the storage picture to any significant degree. Process parameters are presented for the radiation processing of clams and haddock. Results are included from taste tests on irradiated clams and haddock. (C.H.)

11648 (TID-19969) STUDY OF IRRADIATED-PASTEURIZED FISHERY PRODUCTS. [Period Covered]: October 1, 1962–September 30, 1963. Joseph W. Slavin and Louis J. Ronsivalli (Fish and Wildlife Service. Technological Lab., Gloucester, Mass.). Nov. 29, 1963. Contract AT(49-11)-1889. 88p.

Optimum radiation pasteurization dose levels for air-packed, skinless pollock (Pollachius virens) and ocean perch (Sebastes marinus) fillets were determined to be 150,000 and 250,000 rads, respectively. The unirradiated products have a storage life of approximately 12 days in ice. The irradiated products, however, were found to be moderately acceptable for at least 30 days following storage at 33 to 35°F. The quality was determined by a 10 to 12 member organoleptic panel which found no objectionable off-odors or off-flavors which are sometimes associated with the irradiation process. A study of the effects of extended, iced storage of unirradiated, eviscerated haddock on the shelf life expectancy of the fillets from these fish irradiated at 250,000 rads and stored at 33 to 35°F showed that for pre-irradiation storage times up to 7 to 9 days the post-irradiation shelf life was approximately one month. When fish were kept more than about

9 days on ice prior to irradiation of the fillets, the post-irradiation shelf life was markedly reduced. Two storage tests with polyethylene- and polypropylene-packaged fillets and canned fillets showed that the plastic-packaged samples were not so well protected as the canned samples. In fundamental flavor and odor studies, an attempt was made to determine the quantitative composition of the volatiles in each of several species of fishery products so that the changes which develop as a result of storage, cooking, and radiation could be determined. Results obtained thus far show that the number, and in some samples the concentrations, of volatile carbonyl compounds is increased as a result of irradiation, cooking, or extended storage. Total bacteriological plate counts of samples under study were used as criteria of sample quality in addition to the results obtained by organoleptic analyses. Total plate count data collected thus far indicate that irradiation with 250,000 rads reduces the normal fish flora by more than 99%. (C.H.)

11649 (TID-20031) STUDIES ON THE INDUCTION OF MUTATIONS BY IRRADIATION ON PLANT SPECIES OF ECONOMIC IMPORTANCE: MAIZE, WHEAT, TOMATO. (International Atomic Energy Agency, Vienna). [1963]. Contract AT(30-1)-2613. 5p.

Progress is reported in studies on the induction of mutations in maize, wheat, and tomatoes by x irradiation of seed with various dosages. A comparison was made of the radiogenetic response of wheat and tomatoes. Factors affecting species differences in response are discussed. (C.H.)

11650 (TID-20108) STUDIES OF THE EFFECTS OF ULTRAVIOLET RADIATION ON CELL STRUCTURE AND BEHAVIOR. Annual Progress Report, January 1962–January 1963. Jerome J. Freed (Institute for Cancer Research, Philadelphia). Jan. 28, 1964. Contract AT(30-1)-2356. 16p.

A technique was developed for quantitative cytochemical studies of individual living cells using ultraviolet cytospectrophotometry and measurements of cell growth. The technique was used to study the origin of genetically variant cells in cultures of haploid frog cells and the effects of ultraviolet radiation on growth of hamster cells in tissue culture, and related studies of cell culture. Preliminary results are reported. A list is included of publications during the period. (C.H.)

11651 (TID-20121) EFFECTS OF CRANIAL X IRRADIATION ON PSYCHOLOGICAL PROCESSES IN RATS. Final Report. W. J. Arnold (Nebraska. Univ., Lincoln). [1962]. Contract AT(11-1)-249. 17p.

Results are summarized from a series of experiments on the effects of cranial x irradiation on psychological processes in rats. A standard irradiation procedure was developed in which each rat was exposed by means of a lead exposure chamber. Either the whole head or an area directly over the brain was exposed to doses of 300, 800, 2000, or 2500 r. A variety of behavioral processes were tested, including emotionality, maze learning and retention, instrumental learning, discrimination learning, concept formation, and Pavlovian conditioning. Preliminary studies showed that 2500 r whole-head and 5000 r brain area exposure were the maximum practical doses as the mortality rate of higher doses was prohibitive. In all cases the animals developed symptoms of radiation sickness similar to those reported for much lower doses of whole-body irradiation. Weight loss and lethality were positively related to damage and inversely related to age when irradiated. A dose of 5000 r to the brain area of 90-day-old rats shortened the life span about one-third. Data relevant to the variables of age when irradiated, sex, dosage, method of irradiation, and time after irradiation are included with results for each test. (C.H.)

11652 (TID-20122) THE TUMORIGENIC ACTION OF BETA, PROTON, AND ELECTRON RADIATION ON THE RAT SKIN. Progress Report. Roy E. Albert (New York Univ., New York. Coll. of Medicine). [nd]. Contract AT(30-1)-2785. 55p.

Includes Appendices I through V.

Preliminary results are reported for studies on hair follicle injury and tumor induction in rat skin following exposure to electrons, protons, or β particles at various penetrating depths. Data are included from a comparison of uniform and nonuniform surface distributions of high level β particles on the production of skin tumors and skin injury; skin tumor induction by proton irradiation; the relation of dose, penetration-depth, and hair cycle to injury and tumor induction resulting from electron irradiation; and the structure and growth patterns of rat skin tumors induced by β particles. (C.H.)

11653 (UCLA-520(p.27-42)) RADIOBIOLOGY. (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology).

An investigation of the relative sensitivity of the chromophoric group of various pyrimidine compounds to the indirect action of γ radiation, using spectrophotometric techniques, indicated that in positively charged or neutral molecules the 5,6 double bond is the most sensitive group to irradiation but in the ionized forms the methyl and sugar groups are also attacked if present. Preliminary data are included from studies on the radiation chemistry of papain in dilute aqueous solutions, the radiation chemistry of purines in aqueous solutions, and the radiation chemistry of sulfhydryl compounds in aqueous solution. Results are included from studies on the transformation of a strain of Bacillus subtilis using DNA extracted from another strain; the synthesis and transport of egg yolk proteins in hens; theoretical studies on the regulation of metabolic pathways using a model of the mitochrondrial respiratory chain including 5 enzymes and 18 kinetic constants and an IBM 7094 digital computer to solve equations describing the steady state rate of oxygen consumption; nucleocytoplasmic interactions during the differentiation of oral structures in the heterotrich ciliate Stentor coreuleus; and studies on the effects of anoxia and aging on radioinduced chromosome aberrations in rate bone marrow. (C.H.)

11654 (USNRDL-TR-693) RBE OF SOME SODIUM, WATER AND BIOELECTRIC PARAMETERS OF GASTRO-INTESTINAL ABSORPTION. B. E. Vaughan, A. K. Davis, J. T. Cummins, and E. L. Alpen (Naval Radiological Defense Lab., San Francisco). Nov. 8, 1963. 18p. (AD-427755)

An RBE value of 2 to 3 was established for delayed reduction in gastric bioelectric activity, and this effect was readily demonstrated at neutron doses of 160 rad. In the dog, 3 days after irradiation, the unidirectional transfer rates from plasma-to-lumen were decreased for Na and for H_2O. This occurred after x irradiation at 1200 r (air dose) and after neutron irradiation at either 300 or 600 rad but not at 600 r x irradiation doses. An RBE value lying between 2 and 6 can be inferred for the delayed reduction in plasma-to-lumen transfers, depending on depth dosimetry consideration. The electrogenic mechanism in rat

stomach showed Na ion specificity, unlike that in frog. Potentials as measured in vitro agreed with those measured in vivo, and was unaffected except by metabolic poisoning or Na replacement. Plasma-to-lumen unidirectional fluxes showed a consistent pattern of change with respect to irradiation, indicative of decreased permeability at the higher irradiation doses. (auth)

11655 TISSUE DAMAGE TO THE FEET AFTER X-RAY IRRADIATION OF BENIGN CONDITIONS. H. Peskova and R. Vrabec (Medical School, Prague). Acta Chir. Orthopaed. Traumatol. Cech., 28: 302-10(Aug. 1961). (In Czech)

The occasional injury of the foot encountered after radiotherapy for benign disorders presents a difficult task for plastic surgery. Subjective complaints, clinical picture, pathological changes, and danger of malignant transformation of the radiation ulcers are discussed. An analysis of 32 patients treated at this clinic showed an average period of 3.2 months hospitalization. Elimination of radiotherapy for the treatment of nonmalignant conditions is recommended. (BBB)

11656 EXPERIMENTAL STUDIES OF THE ALTERATIONS OF THE EXTRACELLULAR SPACE IN RADIATION SYNDROME. Zoltan Zsebok and Gyozo Petranyi, Jr. (Hungarian Academy of Sciences, Budapest). Acta Med. Acad. Sci. Hung., 19: 137-44(1963). (In German)

Alterations in extracellular space were measured in 121 one- or two-month-old Wistar rats (120 to 180 g weight) for intervals from 1 to 72 hours following whole-body irradiation by administration of 100 mg inulin/kg body weight. Most of the animals subsisted on measured amounts of a prepared diet mix but received water ad libitum. One animal group received no water, another was given a single administration of water perorally equal to 5% of the body weight. The total radiation dose amounted to 1500 r, given at a dose rate of 35 r/min. The inulin (1% solution) was injected into the tail vein under light ether anesthesia at 1, 6, 12, 24, 48, and 72 hours postirradiation, 30 minutes after detachment of the kidney hilus, and 30 minutes before exsanguination. Inulin concentrations in heart blood were measured photometrically. The extracelluiar space (in terms of % body weight) for normal controls, and at 1, 6, 12, 24, 48, and 72 hours was 16.4 ± 1.36, 18.3 ± 0.89, 16.4 ± 2.70, 13.7 ± 0.24, 19.1 ± 1.31, 14.7 ± 1.21, and 9.2 ± 0.30, respectively, for 18, 7, 5, 8, 8, 7, and 6 rats/group. From 65 hours until death there was a marked diminution in the extracellular space. For the entire observation interval the extracellular space decreased by ~54 to 58%. The relation of the results to the gastrointestinal radiation syndrome are discussed. (BBB)

11657 LONG TERM STUDIES IN DOGS RECEIVING SINGLE MASSIVE INJECTIONS OF RADIOACTIVE IRON DURING GROWTH. P. F. Hahn and E. L. Carothers (Meharry Medical Coll., Nashville). Acta Radiol. (N.S.), 1: 423-32(Dec. 1963).

Two groups of litter mate dogs were injected with iron containing the Fe^{59} isotope at levels ranging from 0.74 to 3.3 mC (70 to 435 μC/kg) during active growth. The animals were followed for periods of four and half to six years, respectively, complete blood examinations being conducted at monthly intervals. They developed normally and showed no clinical or hematologic changes up to the time of sacrifice. (auth)

11658 BIOLOGICAL EFFECTS OF WHOLE-BODY PROTON IRRADIATION. John E. Pickering (Brooks Air Force Base, Tex.). Aerospace Med., 34: 942-3(Oct. 1963).

Proton beams, when directed to the eyes of Macaca mulatta at 14, 39, 185, and 730 Mev suggested an RBE ranging between one and two for iridocyclitis, erythema, and cataractogenesis. These values did not vary significantly from ones obtained by comparing 14-Mev neutrons with Co^{60} γ rays. The acute radiation syndrome associated with whole-body exposure of monkeys was difficult to simulate since accelerators that are available have beams of limited diameter and homogeneity. Consequently, a scanning technique in both the horizontal and vertical planes with respect to the beam port was used. The irradiation of 40 monkeys with 730-Mev protons was accomplished by such a technique in collaboration with the Lawrence Radiation Laboratory. Animals were exposed at dose levels of 250, 320, 410, 460, and 535 rad, respectively, based upon one 730-Mev proton equalling 3.89×10^{-8} rad. Probit analysis established $LD_{50/30}$ as 312 rad with the 95% confidence limits ranging between 268 and 362 rad. This $LD_{50/30}$ compares fairly well with that for bomb spectrum neutrons, 393 rad, following whole-body exposure. The calculated RBE is 1.6 as compared to 1.3. Thus, for acute exposures following near uniform whole-body protons, certain similarities to neutrons of energies peaking near 4.5 Mev are evident. When clinical observations (food and water consumption, cage activity, vomiting, diarrhea, purpura, epilation, erythema, edema, death time, and survival time) were compared with previous neutron, gamma, and bomb radiation exposures, it was apparent that 250 rad of protons is a subthreshold dose whereas 535 rad is a suprathreshold for all of the effects examined. Results of peripheral blood studies and pathologic examinations paralleled those previously reported, both in degree and type of change, following exposure to other kinds of ionizing radiation. These findings are discussed in terms of manned space efforts of the future. The proton-irradiated monkeys showed a gradual onset of lethargy, anorexia, and ataxia among survivors at $2\frac{1}{2}$ to $5\frac{1}{2}$ months postirradiation. (BBB)

11659 EFFECT OF RADIATION ON THE DEVELOPMENT OF FACIAL STRUCTURES IN RETINOBLASTOMA CASES. David M. C. Ju, Melvin Moss, and George F. Crikelair (Columbia-Presbyterian Medical Center, New York). Am. J. Surg., 106: 807-15(Nov. 1963).

Radiation injuries occurring as a result of treatment of the eye tumors in children irradiated at this hospital between 1944 and 1950 are reported. The findings presented an opportunity to study extensively the effect of radiation on the growth of the face. Eleven children showed marked stunting effect of the mid-section of the face, and later required corrective surgical procedure. In this group, the eye lesions were discovered at the age of seven weeks to two years of age, and radiation in combination with enucleation was administered at ages varying from two months to six years. The radiation was given through the temporal and nasal ports at doses which varied from 6800 to 8800 r (most patients received 8000 r or more at each port). The effects of radiation fall into two general categories: radiation dermatitis of soft tissue at the area of temporal and nasal ports; and retardation of growth of the mid-section of the face in the area of the orbits and the bridge of the nose, resulting in a unique appearance of the face, which is so characteristic that all the patients studied bear a strong resemblance to each other, as if they were siblings. The radiation-induced changes of skin and soft tissue of temporal and nasal areas are characterized by thinning and atrophy of the skin and subcutaneous tissue. Typical radiation dermatitis, with absence of skin appendages and signs of keratosis and telangectasia of the skin vessels,

is confined only to the precise areas where the special cones were applied. No malignant changes of the skin were noted in these 11 patients. The deformities of bone, which are described in detail, are so uniform that they can almost be recognized as constituting a syndrome. Recommended surgical procedures for these patients who survived radiotherapy and enucleation are suggested. Radiation dermatitis is a precancerous condition, and in other patients in the retinoblastoma series, basal cell or squamous cell carcinoma of the radiated areas developed. The surgical procedures, described in detail and illustrated, eradicate only the irradiated soft tissue and skin. From a theoretical viewpoint all the radiated bony tissue and paranasal sinuses should be removed surgically as a preventive measure. However, this would entail extensive destruction of the midsection of the face, and is so mutilating as to be unfeasible. (BBB)

11660 CARCINOMA OF THE MAXILLARY SINUS FOLLOWING THOROTRAST INSTILLATION: A FURTHER REPORT. Joseph A. Buda, John J. Conley, and Robin Rankow (Presbyterian Hospital, New York). Am. J. Surg., 106: 868-71(Nov. 1963).

Since an earlier report from this hospital in 1960 of three cases of carcinoma of the maxillary sinus following Thorotrast instillation, three additional cases of maxillary sinus carcinoma following Thorotrast instillation are reported. In all three cases, radioactivity of the specimen was significant and found to be the activity of Th and its decay products. The first case gave a history of roentgenographic studies of nasal sinuses with Thorotrast about 20 years prior to admission. The second patient was a 49-yr-old man with a history of having had an injection into the right maxillary sinus about 20 years before admission for allergy studies. The third patient was a 46-yr-old man with a history of allergy and who had had radiopaque material injected into his sinus cavity for roentgenographic studies about 15 years prior to admission. These cases add to the mounting number which implicate the persistent radioactivity of Th as a carcinogenic hazard. The latent period between injection and discovery of tumor in these three cases varied from 15 to 20 years. The carcinogenic effect of the radioactivity of Th and its decay products is discussed. (BBB)

11661 NUMBER OF RAT OVA IMPLANTING AFTER SUB-STERILIZING X-IRRADIATION OF ONE OR BOTH OVARIES. Robert H. Krehbiel and James C. Plagge (Univ. of Illinois, Chicago). Anat. Record, 146: 257-61(July 1963).

Both bilateral and unilateral irradiation of the ovary with a substerilizing dose (800 r) was undertaken in an attempt to clarify the direct effects on fertility of ovarian irradiation. In some cases, one ovary had been removed from the 60-day-old rats before irradiation of the other ovary. Treated females were placed with males at 60, 70, 80, or 90 days of age, and examined, 8 or 9 days after sperm were found in the vaginal smears, to determine the number of implantations. The number of matings was reduced during the period of normal vaginal cycles. Matings did occur after the onset of continuous vaginal cornification. Animals with an irradiated left and a normal right ovary maintained an average number of implantations through pregnancies 1 to 7. The normal ovary compensated for the loss of production by the irradiated ovary. Bilateral irradiation caused a decrease in implantations in the second and third pregnancies. In individual cases, however, the normal complement for a single ovary occurred as late as 201 days after irradiation. The irradiated ovary in the absence of the other ovary compensated by producing more implantations; its period of production was limited to 31 days following irradiation. The average number of implantations was 8.4, which is significantly greater than the number of implantations produced by the irradiated ovary in the presence of a normal or an irradiated ovary during a comparable postirradiation period. Thus the irradiated ovary during this period can compensate by producing more ova if the other ovary has been removed. There was no evident explanation for the failure of these animals to implant at a later date. Resorptions were noted at the time of exploration, but no attempt was made to determine the time or the cause of these. (BBB)

11662 FURTHER AUTORADIOGRAPHIC STUDIES OF THE LENS EPITHELIUM: NORMAL AND X-IRRADIATED RAT EYES. Luigi Scullica, Patricia Grimes, and Norma McElvain (National Inst. of Neurological Diseases and Blindness, Bethesda, Md.). Arch. Ophthalmol., 70: 659-65(Nov. 1963).

Experiments were undertaken to determine the fate of cells irradiated during the DNA synthetic period. For this purpose, rats were injected with H^3-thymidine 1 hour before 1000-r local irradiation. Cells in the synthetic period when the radiation was administered could be identified with this method and could be followed in animals killed at different time intervals after irradiation. Cells of the normal lens epithelium required 16 hours to pass from the beginning of the synthesizing period to the completion of mitosis. Following division, labeled daughter cells migrated from the germinative zone to the postequatorial rows, and by two weeks after tracer injection many radioactive nuclei were found in the lens below. Epithelial cells irradiated while in the DNA synthesis phase underwent degeneration beginning ~8 hr after exposure. The onset of cell death corresponded to the time at which these cells would normally be preparing for mitosis, indicating that they die in abortive divisions. A small percentage of the originally labeled cells survived until three days after irradiation, but by two weeks this number fell almost to zero. The loss of radioactive cells occurred most rapidly in the equatorial zone. The apparent radioresistance of the central cells is most probably related to the longer duration of their cell cycle as compared to that of the rapidly proliferating equatorial cells. These results show that various phases of the life cycle of the lens epithelial cells are profoundly affected by irradiation with a dose of 1000 r, and that it is impossible to assign greater or less sensitivity to any one phase. Cells which are synthesizing DNA at the time of irradiation complete this phase of the cycle, with a possible disturbance of the synthesizing process, but subsequently die in attempted mitosis. In addition, irradiation causes marked destruction of cells in the postequatorial rows, this nonproliferating portion of the population consisting of cells beginning to differentiate into lens fibers and highly susceptible in interphase to radiation-induced nuclear degeneration. All these disturbances are observed within the first 24 hr after irradiation. Despite the resumption of DNA synthesis and mitosis which follows, the proliferative capacity of the cells remains markedly impaired. A high incidence of abnormal mitoses and nuclear fragmentation is seen throughout the observation period accompanied by an obvious reduction in the epithelial population. (BBB)

11663 A STUDY OF POLYPLOIDY IN CERTAIN SPERMATOCYTES UNDERGOING MEIOSIS IN MICE (UNDER NORMAL AND PATHOLOGICAL CONDITIONS). A. Caratzali (Inst. of Oncology, Bucharest). Arch.

Roumaines Pathol. Exptl. Microbiol., 21: 203-11(Mar. 1962). (In French)

Polyploidy is observed in spermiocytes in various mammals, including man, and an attempt was made to determine the significance and possible causes for its appearance. Spermiocytes were examined in smears of testes of mice subjected to a variety of treatments, including ionizing radiation. Of a total of 98 test mice, 23 received a sublethal dose of p-di(2-chloroethyl) aminophenyl-L-alanine (sarcolysine); 19 were treated with the cytostatic agent triethylene-thiophosphoramide (thio-TEPA); 28 mice received a single x-ray dose of 150 r, and 18 a single dose of 400 r; 10 were given peritoneal transplants of cancerous tumors. Irradiated animals (150-r) were sacrificed on the 2nd, 5th, 10th, and 15th day postirradiation, and (400-r) on the 3rd, 5th, and 30th day. A satisfactory chromosomal preparation was obtained by immersing small fragments of testes in 0.25% NaCl solution and then incubating for ½ hr. Individual chromosomes were examined when clearly separated in metaphase. Of 69,000 spermiocytes observed, 146 were diploid, 18 triploid, and 2 tetraploid. A greater percentage of polyploid meioses were found in sarcolysine-treated, irradiated, and cancer-inoculated mice; however, the only statistically significant results were obtained in sarcolysine-treated mice. Among 17 animals presenting nonsynchronous meioses, 10 had been irradiated and 3 sarcolysine-treated. It would seem that asynchronism of spermiocyte plasmodia during kariokinesis, though rare, is a clearer indication of a pathologic state than polyploidy. Another pathologic sign appears to be the reduction in average number of plasmodia observed in mice irradiated with 400 r and sacrificed on the 5th day. It is inferred that spermatocytic plasmodia behave as if they were polyenergids whose morphologic unity may be interrupted by pathogenic factors. (BBB)

11664 SECOND REPORT ON RBE RESEARCH. E. H. Graul (Philipps-Universität, Marburg/Lahn, Ger.). Atompraxis, 10: 28-32(Jan. 1964). (In German)

Radiobiological concepts that are important for understanding the relative biological effectiveness (RBE) of high-energy particles, such as LET, specific ionization, kerma, and first collision dose are defined and interpreted. A critical attitude is formulated in regard to the RBE problem. (auth)

11665 CAN X-IRRADIATION PRIOR TO SEXUAL MATURITY AFFECT THE FERTILITY OF THE MALE MAMMAL (MOUSE)? R. Rugh and M. Wohlfromm (Columbia Univ., New York). Atompraxis, 10: 33-41(Jan. 1964).

CF_1 pregnant mice were x irradiated to 25 or 100 r at gestation ages 0.5 to 18.5. Post-natal males were irradiated at birth, 1, 2, 3 weeks, 1 and 2 months to either 100 or 400 r. Pre- and post-natal x irradiated males were tested for reproductive potential from 2 months of age either to 8 months (for pre-natal series) or to 12 months of age (post-natal series). Pre-natal male mice exposed to 100 r on days 10.5 to 12.5 showed a slight but significant reduction in their reproductive quotient but this was due more to fewer impregnations than to a reduction in litter size, when mated with normal females. This may reflect general physiological disability rather than reduced reproductive potential. The average litter size was not affected. X irradiation of the neo-natal male mouse had no significant effect on fertility when the level of exposure was 100 r. All post-natal males showed some effect at 400 r x irradiation. Exposure of the male mouse at 1 or 2 months of age to 400 r x rays reduced their reproductive quotient considerably. (67% and 71%, respectively). The pre-gonad embryonic stages (0 to 11.5 days) and the stages of active gonad differentiation (12 days gestation to 1 month post-natal) were found to be very radioresistant when the mouse was subsequently fertility-tested. While 400 r did have an immediate effect on the neo-natal testes, this dose was not sufficient to permanently sterilize any male mouse when exposures occurred at any time during the post-natal period of testis differentiation. Further, the neo-natal testes damaged by 400 r x rays (as seen at 2 months of age) showed almost complete recovery by the termination of the study. The recovery of the x-irradiated testis was made from the few early maturation (spermatogonial) stages that escaped x irradiation insult. These became the stem cells for the ultimately recovered testis at 12 months of age. It was concluded that the unformed, undifferentiated testis, and the actively maturing testis are both sufficiently radioresistant as to make full recovery if a few spermatogonia escape x-irradiation death, and that 100 r to the male embryo or 400 r to the sexually maturing male are not sufficient exposures to seriously affect reproductive activity over the normal reproductive period. No consideration is given to any possible genetic sequelae in the offspring produced by the sexually recovered males. (auth)

11666 THE LIFE SHORTENING EFFECTS OF FRACTIONATED X-IRRADIATION ON MICE. W. S. Moos (Univ. of Illinois, Chicago). Atompraxis, 10: 41-3(Jan. 1964).

The effects of fractionated x irradiation on the life span of mice were examined in the light of population variability. Some possibilities of threshold dosages are discussed. (auth)

11667 ON THE FORMATION OF HYPOTHESES IN RADIOBIOLOGY. D. Noack (Institut für Mikrobiologie und Experimentelle Therapie der Deutschen Akademie der Wissenschaften zu Berlin, Jena, Ger.). Atompraxis, 10: 43-5(Jan. 1964). (In German)

It is theoretically demonstrated that a purely exponential dose-effect curve need not necessarily derive hypothetically from the so-called target process alone, but that other interpretations are also possible. The target area is accordingly divided into at least two subareas, and the appearance of the biological effect is proportional to the fraction of the subareas that have been hit at least once. It is possible to decide between the two hypotheses by testing the variances in the measurement values. An experimental example drawn from the radiation inactivation of microorganismus is used to show that the target-process hypothesis need not be rejected, despite the presence of a purely exponential dose-effect curve, and that the alternative interpretation presented is quite probable. (auth)

11668 INFLUENCE OF ^{60}Co IRRADIATION ON THE PHYSIOLOGICAL AND MORPHOLOGICAL PROPERTIES OF SOLANUM NIGRUM PLANTS GROWN FROM IRRADIATED SEEDS. K. Kaindl, Ch. Chwala, and R. Kirschner (Reaktorzentrum, Seibersdorf, Ger. and Österreichische Stickstoffwerke AG, Linz/Donau, Austria). Atompraxis, 10: 48-51(Jan. 1964).

The influence of gamma radiation on the physiological and morphological qualities of test plants of solanum nigrum was examined with reference to radiation dose and the development stage of the plants. Absorption of $KH_2P^{32}O_4$ by leaves was used as a test method. Dry weight has been taken as a standard for growth behavior. A significant increase in dry weight was recorded in the dose range 250 to 10000 rad. At about 10000 to 15000 rad the dry weight falls to the control value, and decreases with further increasing

dose. Absorption by leaves is reduced at lower doses but increases significantly over control values at about 10000 rad. The results recorded are especially distinct in early stages of development. Morphological tests show with increasing dose an increase in percentage variation in leaf shape, verdure, and twisting. No change of length was observed. The number of berries increased rapidly between 20000 and 40000 rad; the dry weight of all berries harvested did not show any significant increase. (auth)

11669 IRRADIATION INJURY TO THE GASTRO-INTESTINAL TRACT: CLINICAL FEATURES MANAGEMENT; AND PATHOGENESIS. I. J. Wood, M. Ralston, and G. R. Kurrie (Royal Melbourne Hospital, Melbourne). Australasian Ann. Med., 12: 143-52(May 1963).

The signs, symptoms, and pathology of irradiation injury to the stomach and bowel are illustrated by the description of three patients treated for carcinoma of the uterine cervix, seminoma of the testis, and malignant teratoma of the testis, respectively. In all three cases the primary tumor had been removed, and direct irradiation was given for proven or suspected recurrence. Irradiation caused both direct irradiation injury to the intestinal epithelium and injury to blood vessels with depletion of blood supply; the latter process probably produced the greater damage. A variety of lesions occurred in the bowel, including ulceration, hemorrhage, perforation, fibrosis, obstruction, and malabsorption. Limited bowel resection became necessary in all 3 cases. Two patients survived, with impaired health but without clinical evidence of recurrence. Improved methods of irradiation are discussed. The dose of irradiation cannot be stated merely by the number of rad or r given, but must be expressed as a complex of the total dose given in a certain time, in certain fractions, and with fields of a specified size. The advantage of large fractions lies in the shorter duration of total treatment time, with probably more effective tumor destruction. The disadvantage of large fractions is that in the main the size of the field used must be restricted and the destructive effect on normal tissues is greater. The use of lower fractions, so as to give the dose in a longer time, reduces the possibility of serious damage to normal tissues, especially in tumors with a low therapeutic ratio, for which a higher total dose is necessary. Damage to normal tissue should be minimal if factors impairing tolerance are fully considered when treatment is being planned. On occasion, it is permissible to take a calculated risk of causing limited damage to normal tissues when no other form of treatment is possible, and when radiotherapy offers either reasonable hope of cure or considerable relief to distressing symptoms. In deciding upon this course, there should be a high degree of probability that there will be a net gain in health status by the patient. It is suggested that, to ensure the maximum irradiation to the cancer with minimum irradiation to the surrounding healthy tissues, more active shielding should be undertaken, even to the extent of laparotomy and displacement of the bowel during the period of irradiation. (BBB)

11670 ACRIFLAVINE MODIFICATION OF NUCLEIC ACID FORMATION, MUTATION INDUCTION AND SURVIVAL IN ULTRAVIOLET LIGHT EXPOSED BACTERIA. C. O. Doudney, Billie F. White, and Betty J. Bruce (Univ. of Texas, Houston). Biochem. Biophys. Res. Commun., 15: 70-5(Feb. 18, 1964).

The effects of acriflavin, caffeine, and certain basic dyes on RNA, DNA and protein synthesis, survival, and mutation-induction with uv-exposed bacteria are compared. It is established that the agents exert some action on uv-exposed cells which results in increased mutation frequency response and lethality, as well as blockage of RNA, DNA, and protein synthesis. Acriflavine effects on macromolecular synthesis, mutation induction, and lethality are described. (auth)

11671 OOGENESIS AND RADIOSENSITIVITY IN COCHLIOMYIA HOMINIVORAZ (DIPTERA: CALLIPHORIDAE). Leo E. LaChance and Sarah B. Bruns (Agriculture Research Service, Kerrville, Tex.). Biol. Bull., 124: 65-83(Feb. 1963).

In normal Cochliomyia hominivorax females, gross ovarian growth, correlated with the age of the adult from emergence to sexual maturity, was measured. Studies showed that the size of the ovary doubles between the first and second day of adult life, increases more than 5-fold between the second and third day, and exhibits a total increase of approximately 60-fold from emergence to sexual maturity. A cytological study of the ovarioles was conducted to determine the sequence of events in normal oogenesis. The cytology of the reproductive system, from 5-day-old pupae to sexually mature females, is described. The effects of gamma radiation on gross ovarian growth indicated that newly emerged females are more radiosensitive than 5-day-old pupae, and that irradiation of 2-day-old females has little effect on subsequent ovarian gorwth. The cytopathology of the irradiated ovary was studied after similar doses of radiation were delivered to various developmental stages. The general sequence of events after treatment was as follows: after low doses, growth is slower than normal but not completely arrested. If treatment is given to 5-day-old pupae, grossly malformed oocytes are not often encountered, but second egg chambers frequently do not form. When females 0–4 hours old are irradiated, growth in the first egg chamber is delayed considerably, and is often followed by complete degeneration of the first egg follicle or the formation of grossly malformed oocytes. In these studies, the most radiosensitive stage encountered was that period during which the egg chambers contain nurse cells undergoing endomitotic replications of chromosomal material. (auth)

11672 X-IRRADIATION-INDUCED CONGENITAL ANOMALIES IN HYBRID MICE. Roberts Rugh and Marlis Wohlfromm (Columbia Univ., New York). Biol. Bull., 124: 303-10(June 1963).

Increased radioresistance is manifested in hybrid embryos exposed to 200 r at 8.5 days of embryonic development when divergent stocks of mice are cross-bred, as determined by the incidence of congenital anomalies. This is evidence of embryonic heterosis. When hybrid mice are mated with hybrids (of the same crosses) or with either of the parental stocks, it is apparent that the presence of CF1 influence affords the embryos more radioresistance only when the cross is with the CF1 line. The presence of CF1 genes brings the results up to the pure CF1 data so that it appears that there is a sort of dominance effect which becomes heterosis when the proportion of CF1 genes exceeds this minimum in these heterozygous embryos. In hybrid combinations the development of central nervous system (CNS) congenital anomalies appears to be more frequently related to the presence of CF1 genes than to those from the C57 strain. Conversely, resorptions appear to be more directly related to the presence of the C57 genes. Even in the pure strains this is substantiated because 14% of the CF1 embryos and none of the C57 embryos showed CNS anomalies following 200 r x-rays at 8.5 days' gestation. Likewise, the C57 strain embryos reacted to this exposure by producing 92% resorptions while the CF1 embryos showed only 32%. The data on congenital anomalies

seem at first to be confused. This is due to the simple fact of relative radioresistance of the CF1 embryos, which allows them to survive and hence to develop x-irradiation-induced congenital anomalies, particularly of the central nervous system. The radiosensitivity of the C57 strain reduced their survival. As a result of this, there are fewer survivors to develop CNS anomalies. As in other studies in heterosis, it appears that this embryonic hybrid vigor is correlated with maximum heterozygosity and is reduced as this condition is diluted toward either of the parental conditions. Radioresistance (or, conversely, radiosensitivity) of the embryo appears to be closely allied to inherent genetic factors quite different in the two strains of mice. In one strain there is the greater tendency to resorption and death and in the other to survival with attendant development of congenital anomalies. (auth)

11673 AN ORIENTATIONAL RESPONSE TO WEAK GAMMA RADIATION. Frank A. Brown, Jr. (Northwestern Univ., Evanston, Ill.). Biol. Bull., 125: 206-25(Oct. 1963).

The common planarian worm, Dugesia dorotocephala, displays a significant orientational response to increase in Cs^{137} gamma radiation when the increase is no greater than six times background. The worms are able to distinguish the direction of the weak gamma source, turning away from it, whether it is presented on the right or left side. The response sign is, therefore, the same as that of the response of these negatively phototactic worms to visible light. There is a clear compass-directional relationship of the responsiveness to the experimental gamma radiation. A conspicuous negative response is present when the worms are traveling northward or southward in the earth's field with the gamma change in an east-west axis. No statistically significant mean turning response to the gamma radiation is found when the worms are traveling eastward or westward in the earth's field with the gamma change in a north-south axis. The previously observed annual fluctuation in the character of the monthly orientational rhythm of north-directed worms has been confirmed in an additional year of study. During colder months, the rhythm is monthly; during warmer months it is semi-monthly. There is a semi-monthly fluctuation in the response of Dugesia to weak gamma radiation during mid-morning hours, the worms turning away from the source for four days prior to new and full moon, and toward it for two days following new and full moon. The stronger the field strength, up to 9 times background, the larger the amplitude of the rhythm. There is a direct relationship between intensities of gamma radiation between that of background and nine times background, and the strength of the negative response of the worms. Evidence suggests that the negative response of Dugesia to a gamma source may be modified by experimental alteration of the natural ambient electrostatic field. Some possible biological significances of this remarkable responsiveness to gamma radiation, and its particular properties, are discussed briefly. (auth)

11674 THE COMBINED EFFECT OF ULTRAVIOLET IRRADIATION AND HEAT UPON CLEAVAGE OF SEA URCHIN EGGS. Lois M. Hutchings (Western Univ., Cleveland and Cleveland Metropolitan General Hospital). Biol. Bull., 125: 302-10(Oct. 1963).

Thermal treatment (36°C. Arbacia; 31.4°C. Strongylocentrotus) applied to sea urchin eggs in graduated exposures causes a delay in first cleavage that is roughly proportional to the exposure. Graduated intensities of 254 mμ of ultraviolet light produce a delay in first cleavage that is less pronounced with increasing intensities of light. Treatments involving both ultraviolet irradiation and heat retard the first cleavage of sea urchin eggs more than either agent alone. Curves of cleavage delays of Arbacia eggs caused by combined ultraviolet light and 36°C, either one serving as the major physical agent and the second as the minor physical agent, show no statistically significant difference from a hypothetical curve representing a sum of the two single-agent delays. Although there is no evidence that ultraviolet irradiation preceding heat causes an exaggerated injury, which application of the same agents in reverse order fails to do with Arbacia eggs, there is an indication that such sensitization tends to occur in Strongylocentrotus eggs pretreated with 254 mμ of ultraviolet radiation and then subjected to heat at 31.4° ± 0.5°C. Strongylocentrotus eggs pretreated to a temperature of 31.4°C, followed by exposure to ultraviolet irradiation (254 mμ), show significantly less delay in achieving first cleavage than eggs subjected only to a temperature of 31.4°C. (auth)

11675 CHANGES IN PERMEABILITY OF CELLS IN ALLIUM CEPA L. FOLLOWING X-RAY IRRADIATION. Bohumil Hluchovský and Vladimír Srb (Charles Univ., Königgrätz, Czechslovakia). Biol. Zentr., 82: 73-94 (Jan.-Feb. 1963). (In German)

The effects of various doses of x-ray irradiation (1000, 5000, and 25,000 r) on the permeability of plasmatic cell membranes in epidermal cells of Allium cepa L., variety Všetaty seedling, were studied by means of the plasmolytic method. The following solutions were used as plasmolytics: 1 and 0.64M KNO_3 and 1M saccharose, pH 5. A total of 2149 measurements were made. The plasmolytic method refined by time evaluation of the onset of the plasmolytic forms, border, concave-convex, and complete (convex-) plasmolysis, was found to be applicable for the determination of early radiation damage to cell permeability and can be developed to a suitable testing method of the effect of ionizing radiation. Only the first form, border plasmolysis, could not discover the noxious changes caused by irradiation as its course was of too short duration. Duration of complete plasmolysis was prolonged if KNO_3 was used as plasmolytic and became shorter or remained closely below the control level if saccharose was used in plasmolysis. This fact was not affected by the radiation dose. Irradiation with x rays considerably changed the permeability of plasmatic cell membranes for water and electrolytes, not however for nonelectrolytes. The observed effect may perhaps be explained by partial depolarization of membranes under the influence of irradiation, which makes possible an easier permeation of electrically charged particles while electroneutral particles are not essentially influenced in their permeation. (auth)

11676 INVESTIGATIONS OF X-RAY MUTATIONS OF OENOTHERA BERTERIANA. II. ON THE REASONS FOR F_1 VARIATIONS AFTER X IRRADIATION. Carl-Gerold Arnold (Universität, Erlangen, Ger.). Biol. Zentr. 82: 185-207(Mar.-Apr. 1963). (In German)

Oenothera berteriana oöspheres ready for conception were treated with x radiation with various doses. The corresponding flowers were pollinated with unirradiated B · 1 pollen. In the hybridization scheme for discovering external karyotic mutations, the variations in which the F_1 emerges were crossed with the two half-heterogamous B · II and 1 · II. In the same way the F_2 generation was handled. Extrachromosomal mutations could not be detected. The absence of self-progeny of F_1 variety, the appearance of normal progeny in the self- and cross-breeding

of F_1 varieties, possible reasons for the normalization of the F_2 generation, the appearance of heteroploid mutations, and the appearance of a diploid mutation are discussed. (M.C.G.)

11677 COMPLICATIONS DUE TO RADIATION OF FOREHEAD AND SCALP. Z. Neuman (Hadassah Univ. Hospital, Jerusalem). Brit. J. Plastic Surg., 16: 99-105 (Jan. 1963).

The case histories of five patients are presented; three were treated with x rays or radium for many years for small, localized malignant lesions of the forehead. When these patients were admitted to the hospital, their skin had been destroyed and bone exposed with persistent malignancy. Two further patients who received radiation therapy for small malignancies of the scalp developed severe neurologic symptoms. Two of the malignancies were basal cell carcinomas, the 3rd of undisclosed type. One of the basal cell carcinoma cases died of generalized metastases, whereas the other 2 remained cancer-free. Repair of the radiation-induced ulcers by plastic surgery is described in detail, the results being considered successful in each case. It is concluded that wide excision with plastic repair should be the treatment of choice in malignancies of the forehead and scalp. The widest primary excision and plastic repair is never as difficult as the one required after complications due to irradiation, where the skin is severely damaged, bone exposed, secondary infection present, and the tumor has recurred. (BBB)

11678 A REVIEW OF SOME FACTORS AFFECTING THE RADIATION DAMAGE TO BONE FROM INGESTED RADIUM. F. W. Spiers (Univ. of Leeds, Eng.). Brit. J. Radiol., 37: 85-8(Feb. 1964).

Factors affecting the radiation damage to bone from ingested radium are reviewed in relation to the sites of damage, the uptake and excretion of radium and the physical dose delivered to the critical tissues under a number of conditions of exposure. Some consideration is given to the model for calcium metabolism suggested by Eve and Dolphin and to the departures from this model which seem likely if the known natural radium burden is to be compatible with the approximately known radium intake. It is suggested that the sensitive techniques of measurement now available could profitably be used to study natural levels of radium in human beings at natural levels of intake and excretion. (auth)

11679 PSEUDOSARCOMATOUS CHANGES IN THE CERVIX FOLLOWING IRRADIATION FOR CERVICAL CARCINOMA. J. L. Gray, N. A. Janovski, and Henry Clay Frick, II (Columbia-Presbyterian Medical Center, New York). Bull. Sloane Hosp. Women, 9: 44-7 (1963).

A case is presented in which pseudosarcomatous changes of the cervix occurred after internal and external radiotherapy was completed for a stage I epidermoid carcinoma of the cervix. Changes were noted ~9 months after completion of therapy. The patient was treated with a Ra applicator which delivered 7000 r to point A and 1750 r to point B, as well as external radiotherapy. By utilizing large anterior and posterior pelvic ports, an additional 2300–2400 r midline dose was administered. The total dose to point A was 9300 r and approximately 5050 r to point B. The patient responded well to external therapy, having only mild nausea, diarrhea and moderate dermatitis. A follow-up study with biopsies showed pseudosarcomatous change. Histopathologic study of sections of the cervix showed marked fibrosis and sclerosis of the connective tissue stroma. The exocervix was epithelialized and there was no evidence of neoplastic changes. However, the connective tissue stroma of the cervix showed microscopic masses formed from elongated, spindle-shaped, relatively large cells. The nuclei of the connective tissue cells showed considerable degree of hyperchromatism. No mitotic divisions were encountered. Between the proliferated and elongated cells there was a considerable degree of collagen tissue. The lesion was interpreted as being pseudosarcoma of the cervix following internal and external radiation. No evidence of residual carcinoma was observed. Pseudosarcoma of the cervix, as the end-result of external, internal or combined radiotherapy for preexisting cervical neoplasms may be clinically misinterpreted, as in the case presented, as a residual neoplasia. The postirradiation alterations in connective tissue lead it to assume microscopic features of neoplasia. Postirradiation pseudosarcoma of the cervix should be considered in evaluating tumor response to radiotherapy for cervical carcinoma. A review of the literature shows two earlier analogous reports. The term pseudosarcoma was applied here to indicate a presumably non-neoplastic connective tissue mass with a histological appearance which is deceivingly suggestive of a fully malignant form of true sarcoma capable of metastasis. (BBB)

11680 THE EFFECT OF LONG ULTRAVIOLET RADIATION ON THE DEVELOPMENT OF TUMORS INDUCED BY 20-METHYLCHOLANTHRENE. Janet Howell Clark (Johns Hopkins Univ., Baltimore). Cancer Res., 24: 207-11(Feb. 1964).

When mice are exposed to a moderate dose of long ultraviolet radiation ($4-8 \times 10^7$ ergs/sq cm), immediately after painting with 20-methylcholanthrene, the rate of papilloma development is accelerated. Within these limits increasing the amount of radiation increased the acceleration. There was no effect on the rate of carcinoma development. When prolonged radiation was given ($10-18 \times 10^7$ ergs/sq cm), there was an initial acceleration of papilloma development, but the early tumors regressed so that, eventually, the rate of tumor development in radiated groups was slower than in the controls. In addition, there was a retardation of the carcinogenic process. (auth)

11681 GAS PLASMA IRRADIATION OF RICE. III. INFLUENCE ON BROWN RICE AND RICE BRAN. A. S. Roseman, J. T. Hogan, R. B. Stone, and J. C. Webb (Univ. of Tennessee, Knoxville). Cereal Chem., 40: 568-75(Sept. 1963).

A study was undertaken to determine if gas plasma irradiation exerted any influence on the stability of the oil in rice bran or brown rice, and to ascertain if the petroleum ether-extractable lipids from irradiated bran or brown rice differed from that extracted from nonirradiated controls. The rate of free fatty acid development in the lipids of stored brown rice and in the stored bran separated from rice kernels was much slower in irradiated samples than in nonirradiated controls. Gas plasma irradiation profoundly changed the chemical and physical characteristics of rice oil from both stored brown rice and stored separated rice bran. The average molecular weight of the oil extracted from irradiated rice bran had increased. In addition, the oil was less saturated than that of the nonirradiated controls. The investigation demonstrated that these changes are effected specifically by the gas plasma irradiation rather than by the coincidental heat-vacuum effect of irradiation. The physical changes in the characteristics of the oil brought about by irradiation may be of significance in the technological uses of this product. (BBB)

11682 RELATION OF LIVER INFILTRATION BY FATS TO ANEMIA IN REPEATEDLY IRRADIATED RATS AND RATS TREATED AFTER IRRADIATION BY BLOOD TRANSFUSIONS. M. Skalka (Biophysical Inst., Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 12: 336(Oct. 1963).

Studies showed that the main mechanism of infiltration of liver by fat after irradiation is due to intense anemia and the damage to liver tissue. (OTS)

11683 CONTRIBUTION TO THE KNOWLEDGE COVERING CHANGES DUE TO EFFECT OF PENTAZOLE UPON IRRADIATED ANIMALS. V. Grossmann (Charles Univ., Hradec Kralove, Czechoslovakia). Cesk Fysiol., 12: 357(Oct. 1963).

An experiment conducted on mice indicated that the toxicity of pentazole is lower upon irradiated animals. The decrease is highest on the 3rd day after irradiation. (OTS)

11684 CHANGES IN PRIMARY RESPONSES IN BRAIN MEMBRANE IN RATS IN DIALYTIC NARCOSIS FIRST DAY AFTER IRRADIATION BY A DOSE OF 1000 r. R. Tikal (Charles Univ., Hradec Kralove, Czechoslovakia). Cesk. Fysiol., 12: 357-8(Oct. 1963).

Radiation was found to lower primary responses in brain membrane in rats. (TCO)

11685 INFLUENCE OF IRRADIATION OF THE WHOLE BODY ON THE DISTRIBUTION OF PETHIDINE AND NORPETHIDINE IN THE ORGANISM OF RATS. J. Kvetina and J. Cellerova (Charles Univ., Hradec Kralove, Czechoslovakia). Cesk. Fysiol., 12: 360(Oct. 1963).

The level of pethidine in the blood of irradiated rats was higher than in nonirradiated ones, but lower in the brain. Similar results were obtained with norpethidine. (OTS)

11686 CORRELATION OF DOSE AND EFFECT IN OCCURRENCE OF CELLS OF GIGANTIC DIMENSIONS AFTER IRRADIATION OF CELL TISSUE. M. Klimek and M. Vlasinova (Inst. for Biophysiology, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 12: 368-9(Oct. 1963).

No changes in the size of the cells were found in the limits of 1200 to 3000 r. An increase to 4000, 6000, and 8000 had no further effect. Between 150 and 800 r the effect was a linear function of the amount of irradiation. Below 75 r the effect was small. (OTS)

11687 COMPARISON OF THE EFFECT OF IRRADIATION AND CYTOSTATICS UPON DESOXYRIBOPOLYNUCLEOTIDES OF TISSUES. J. Matyasova and M. Skalka (Inst. for Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk, Fysiol., 12: 370-1(Oct. 1963).

Experiments conducted on mice and rats are described. Both irradiation and cytostatics influences caused disintegration of cells, and liberation of desoxyribopolynucleotides. (OTS)

11688 EARLY CHANGES IN THE ZONE OF GROWTH OF RAT'S FANGS AFTER IRRADIATION BY X-RAYS. B. Bily (Purkyne Univ., Brno). Cesk. Fysiol., 12: 375(Oct. 1963).

Changes due to irradiation of 200 to 4800 r per day were studied. It was found that 2400 r destroys odontological epithelium. Below 1200 r damage is healed; above this limit damage is permanent. (OTS)

11689 CONTRIBUTION TO THE EFFECT OF RADIATION AS A FUNCTION OF DOSES AND NATURE OF THE IRRADIATED PART OF ORGANISM. V. Grossmann (Charles Univ., Hradec Kralove, Czechoslovakia). Cesk. Fysiol., 12: 375-6(Oct. 1963).

Experiments with rats showed that the head and abdomen were the most sensitive parts of the body. (OTS)

11690 RADIOSENSITIVITY IN THE REGION OF BIOLOGICALLY IMPORTANT MACROMOLECULES. F. Hercik (Inst. for Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 12: 376(Oct. 1963).

The mechanism of radical liberation from macromolecules and the mechanism of their reactions are discussed. Protection by the SH- group and the effect of ultraviolet light are discussed. (OTS)

11691 INFLUENCE OF RADIATION UPON OSMOTIC PROCESSES IN CELLS. F. Hercik (Inst. for Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 12: 376(Oct. 1963).

The influence of ultraviolet and x radiation and alpha particles from Po on leaves of Begonia Semperflorens were studied. Damage to the leaves was considered to be due to the decomposition of desoxyribonucleic acid. (OTS)

11692 REACTION OF SOME CROP VEGETATION TO REPEATED IRRADIATION. R. Honcariv, L. Kovac, and V. Danko (Safarik Univ., Kosice, Czechoslovakia and Agronomical Station, Maly Saris, Czechoslovakia). Cesk. Fysiol., 12: 376-7(Oct. 1963).

The effects of Co^{60} gamma irradiation on wheat and barley during the whole vegetation period were studied. The result was a decrease of the number of grains in a sheaf. Wheat was more resistant than barley. (OTS)

11693 RESISTANCE TO IRRADIATION OF BACTERIOPHAGES. Z. Hradecna (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 12: 377-8(Oct. 1963).

Loss in the ability of the virus to cause infection was studied, after it had been subjected to uv and x irradiation. Reactivation of the virus is discussed. (TCO)

11694 CHANGES IN THE PERIPHERY BLOOD PICTURE AND IN THE MITOTIC INDEX OF BONE MARROW OF RATS AFTER IRRADIATION. O. Chlebovsky, M. Praslicka, J. Horak, Z. Karpfel, and R. Honcariv (Safarik Univ., Kosice, Czechoslovakia; Radiobiological Lab., Czechoslovak Academy of Sciences, Kosice; and Inst. for Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 12: 378(Oct. 1963).

Rats were subjected to Co^{60} radiation for 137 days. Daily doses varied between 0.16 and 105 r. Various changes due to the irradiation are described and discussed. (OTS)

11695 CONTRIBUTION TO THE PROBLEMS OF RADIOSENSITIVITY OF MYOCARDIUM. V. Jurkovic and L. Vokrouhlicky. Cesk. Fysiol., 12: 378-9(Oct. 1963).

Experiments on rabbits subjected to 1000 r are described. (TCO)

11696 RADIOSENSITIVITY OF CELL STRUCTURES. Z. Karpfel (Biophysical Inst., Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 12: 379(Oct. 1963).

The influence of radiation upon the structure of the cell nucleus and on cytoplasm and resulting chromosome changes are described. Reversible damage to cells was studied. The formation of gigantic cells is discussed. (OTS)

11697 MITOSIS OF BONE MARROW AS CRITERION OF RADIOSENSITIVITY. Z. Karpfel, J. Cincarova, and Z. Papezova (Inst. of Biophys., Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 12: 379(Oct. 1963).

Chromosome aberrations after irradiation were studied on mice. A connection between the number of spontaneous aberrations and the number of aberrations found 4 to 7 days after irradiation was found. The number of spontaneous aberrations may be used to predict radiosensitivity of the bone marrow. (OTS)

11698 OCCURRENCE OF CHROMOSOME ABERRATIONS AFTER THE INTRODUCTION OF ALLOGENIC MARROW INTO AN IRRADIATED HOST. Z. Karpfel and B. Koukalova (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 12: 379-80(Oct. 1963).

Aberrations in the marrow are caused by fragments of desoxyribonucleic acid penetrating the cells and by the fact that this acid partially replaces the acid contained in the healthy marrow. (OTS)

11699 CONNECTION BETWEEN RESISTANCE TO IMMUNIZATION AND IRRADIATION OF TUMORS. P. Koldovsky (Inst. of Experimental Biology and Genetics, Czechoslovak Academy of Sciences, Prague). Cesk. Fysiol., 12: 380-1(Oct. 1963).

A tumor induced by methylcholanthrene in mice was studied in vitro. Doses up to 300 r induced the growth, above 900 r growth was inhibited, but the cells were resistant to radiation and were growing selectively. (OTS)

11700 RADIOSENSITIVITY OF BONE MARROW OF MICE IN VITRO AND THE CONNECTION TO THE AGE OF THE DONOR. B. Koukalova (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 12: 381-2(Oct. 1963).

Mice 1 to 27 weeks old were studied. Increasing age decreased sensitivity. (OTS)

11701 CONTRIBUTION TO THE QUESTION OF RESISTANCE TO IRRADIATION BY LIVER TISSUE IRRADIATED IN VIVO AND IN VITRO. J. Kvetina (Charles Univ., Hradec Kralove, Czechoslovakia). Cesk. Fysiol., 12: 382(Oct. 1963).

In whole-body irradiation a statistically important increase in esterolytic activity of liver homogenate is detected, even at low levels of irradiation. In vitro doses above 10 000 r are required to observe the same effect. (OTS)

11702 SENSITIVITY OF SOME STRAINS OF GALLUS DOMESTICUS TO IRRADIATION BY X-RAY IN A SINGLE DOSE ON THE WHOLE BODY AT 800 r. P. Mach, Vl. Mrva, and A. Vinkler (Research Inst. of Veterinary Medicine, Brno). Cesk. Fysiol., 12: 382-3(Oct. 1963).

Seven strains aged 1 year were studied. Each strain showed an individual specific reaction. (OTS)

11703 RADIOSENSITIVITY OF DESOXYRIBONUCLEIC CELLS OF HEMATOPOIETIC AND LYMPHATIC TISSUES. J. Matyasova and M. Skalka (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 12: 383-4(Oct. 1963).

The two kinds of tissue show very high sensitivity to irradiation. Studies on mice showed decomposition of desoxyribonucleic cells in spleen and thymus by doses that did not affect other body tissues. (OTS)

11704 CHANGES IN ENERGETIC BALANCE AFTER IRRADIATION. J. Misustova (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 12: 384(Oct. 1963).

Male mice 3 to 4 months old subjected to 1000 r were studied. Some discrepancies between heat production and heat release by the body were caused by the irradiation. (OTS)

11705 RADIOSENSITIVITY AND ITS QUANTITATIVE EVALUATION. L. Novak (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 12: 384-5(Oct. 1963).

The intensity of radiation and time of exposure should be evaluated together with biological, physical, and mathematical parameters. (OTS)

11706 PROBLEMS OF DIFFERENCES IN INDIVIDUAL SENSITIVITY TO RADIATION. M. Pospisil (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 12: 385(Oct. 1963).

The question is discussed in general terms and attention is drawn to the influence of body constitution of an individual. (OTS)

11707 FORECASTING OF INDIVIDUAL DIFFERENCES IN REGENERATION OF LYMPHATIC TISSUE AFTER IRRADIATION. M. Pospisil (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 12: 385(Oct. 1963).

The relation of Na and K ions in urine of mice was studied as indicators of regeneration ability. (OTS)

11708 BALANCE OF ENERGY AND FORECASTING OF RADIOSENSITIVITY OF RATS. M. Pospisil, L. Novak, and M. Hosek (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 12: 386(Oct. 1963).

Male rats 53 to 63 days old were irradiated by a dose of 450 r and their weight followed for 28 days. (OTS)

11709 SENSITIVITY OF CELLS AND HIGHER ORGANS TO IRRADIATION. M. Skalka (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 12: 387(Oct. 1963).

Damage to tissues was caused in 4 ways: death of cells, interruption of mitosis, interruption of synthesis of desoxyribonucleic acids, and by damage to genetic materials. Some parts of the body, that were not directly irradiated, were damaged by substances that move through the body from the damaged organs. (OTS)

11710 CONTENT OF DESOXYRIBONUCLEOTIDES IN TISSUES AFTER LOW DOSES OF IRRADIATION. M. Skalka and J. Matyasova (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 12: 387(Oct. 1963).

Experiments on mice and rats were conducted and the connection between the amount of desoxyribonucleic proteins in blood and the amount of irradiation suffered was determined. An attempt was made to find the amount of radiation to which the organism was exposed by this method. (OTS)

11711 RADIOSENSITIVITY OF CELLS. J. Soska (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 12: 388(Oct. 1963).

Radiosensitivity of cells is due mainly to the sensitivity of chromosomes. It is a function of the physical and chemical structure of the cells. (OTS)

11712 SPECIES AND STRAIN RADIOSENSITIVITY OF SOME REPRESENTATIVES OF GENUS ALLIUM L. DETERMINED BY GERMINATION OF SEEDS. V. Srb (Charles Univ., Hradec Kralove, Czechoslovakia). Cesk. Fysiol., 12: 388-9(Oct. 1963).

Various kinds of Genus allium L. responded to irradiation in an identical way. Age of seeds had no influence. (OTS)

11713 CHANGES IN THE SENSITIVITY OF CELLULAR PERMEABILITY TO X-RAY IRRADIATION CAUSED

BY STORAGE OF BULBS OF ALLIUM CEPA L. V. Srb (Charles Univ., Hradec Kralove, Czechoslovakia). Cesk. Fysiol., 12: 389(Oct. 1963).

The longer the storage period, the slower the completion of plasmolysis. This is considered to be due to the loss of water during storage. (OTS)

11714 COMPARISON OF THE EFFECT OF DESOXYRIBONUCLEIC ACID OLIGONUCLEOTIDES AND PYRIMIDINE MONONUCLEOTIDES ON THE COURSE OF MITOTIC SEPARATION IN IRRADIATED AND UNIRRADIATED BONE MARROW. J. Slotova and Z. Karpfel (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 12: 390(Oct. 1963).

Experiments conducted on mice indicated that the occurrence of aberrations in bone marrow increased after an injection of isologous desoxyribonucleic acid from the brain and after injection of heterologous desoxyribonucleic acid from the thymus of calf, but did not increase after injection of isologous desoxyribonucleic acid from hemoforming tissue. The aberrations started to occur 4–6 hours after the injection. An increased occurrence was noticed 6–16 hours after injection, that is in the S and G_2 phases of the mitotic cycle. (OTS)

11715 DECREASE OF EUPLOIDIA IN THE CELLS OF BONE MARROW IN PEOPLE WITH INTERNAL CONTAMINATION BY SOME RADIOISOTOPES. R. Tuscany and V. Kiener (Inst. of Hygiene of Work and of Occupational Diseases, Prague). Cesk. Fysiol., 12: 391(Oct. 1963).

People contaminated with Sr^{90} and Ra^{226} were studied. Caryologic examination was expressed as percent of euploid cells from all metaphases determined by microphotography. (OTS)

11716 PROBLEMS OF LEUKEMIA. Chron. World Health Organ., 16: 399-404(Nov. 1962).

The role of ionizing radiation, among other possible etiologic factors, in leukemogenesis is discussed. It is stated that studies, conducted at the Hiroshima University Research Institute of Nuclear Medicine and Biology, show clearly that ionizing radiation does induce leukemia in man. The incidence of leukemia in survivors of the atomic bombs dropped in Nagasaki and Hiroshima is discussed and it is concluded that there is no apparent reason why the populations of these two cities should have a higher leukemia rate than the Japanese population in general other than that they have been exposed to the ionizing radiation of the bombs. The question has been raised whether other medical uses of radiation do not increase the risks of leukemia, even if only to a minor degree. A discussion is provided of the difficulties of extrapolating to man the results obtained in inducing leukemia in animals by ionizing radiation. No success has been achieved in transmitting leukemia by natural contact between irradiated mice that develop leukemia and nonirradiated mice. Also discussed are various chemical agents known to be capable of inducing leukemia or modifying its frequency, such as methylcholanthrene, dibenzanthracene, mineral oils, and benzene. (BBB)

11717 EFFECT OF THE INCORPORATION OF 5-BROMODESOXYURIDINE ON MITOSIS AND THE SENSITIVITY TO X RAYS. Marie Gontcharoff and Baschini Rao (Faculté des Sciences, Reims, France and Univ. of California, Berkeley). Compt. Rend., 257: 4045-7(Dec. 16, 1963). (In French)

The effect of 5-bromodesoxyuridine (Budr) on cellular division and on sensitivity to x radiation was studied on fertilized eggs of the roundworm Strongylocentrus purpuratus. Four groups of samples were studied: a control group not treated with Budr and unexposed to x radiation; a group not treated with Budr but exposed to x radiation; a group treated with Budr but not exposed to x radiation; and a group treated with Budr and exposed to x radiation. The results are shown graphically. When the nontreated eggs are irradiated, the delay in cellular division is 55 min; the delay is 63 min for treated samples irradiated with the same dose. The significance of these results is discussed. (J.S.R.)

11718 MODIFICATIONS OF FREE PLASMIC AMINO ACIDS IN THE MOUSE C_3H AFTER IRRADIATION. Claude Bohuon, Jean-Claude Delarue, and Maurice Tubiana. Compt. Rend., 257: 4227-9(Dec. 23, 1963). (In French)

Irradiation at 500 r causes important modifications of the amount of some free blood amino acids of the C_3H mouse. In particular, on the third day after irradiation, the amounts of tryptophane and tyrosine are considerably reduced. (tr-auth)

11719 GLOBULE-PLASMA IONIC TRANSFERS AND X-IRRADIATION. Jean Philippot (Faculte de Medecine, Montpellier, France). Compt. Rend., 258: 1072-5(Jan. 20, 1964). (In French)

The effect of x radiation on the globule-plasma transfer of K^+ was studied. (D.C.W.)

11720 HISTOLOGICAL STUDIES OF PREOPERATIVELY IRRADIATED MAMMARY CARCINOMA. H. Hamperl, F. O. Huhn, C. Kaufman, and K.-G. Ober (Universitäts-Frauenklinik, Cologne). Deut. Med. Wochschr., 88: 616-20(Mar. 29, 1963). (In German)

Although about 900 papers on the use of preoperative x irradiation of mammary carcinoma have appeared in the literature there is still some question as to its effectiveness. From a total of 150 patients an intensive histological study was made of 14 of them who had received a preoperative x radiation. In all but two a positive diagnosis of mammary carcinoma was made by biopsy. With one exception there was no evidence by clinical or palpatory study of regional lymph node involvement. The radiation dosage varied as a function of the treatment plane and the daily surface dose was ~200 r for a total of 2000 to 4000 r to the supraclavicular, axillary, or mammary fields. The interval between irradiation and biopsy was from two days to five months, depending on the skin reaction to the radiation. In six cases the primary tumor disappeared after the radiation treatment. By very careful and exhaustive microscopic studies of tissue preparations from the entire affected axillary areas it was possible, without exception, to demonstrate in each patient carcinomatous cells in the lymph nodes. These results emphasize the fact that if the results from only a few sampled lymph nodes are negative it is unwise to conclude that the entire tissue is tumor-free. Although regressive histological changes in tumor cells present may be caused by radiation it is possible, because these changes are also seen in unirradiated tumor tissue, that the radiation may have only accentuated the regressive process. The fact that tumor tissue with no evidence of alteration is still found along with these changes is much more clinically significant. These considerations should be taken into account when, after removal of the primary tumor, it is thought that radiation alone is sufficient treatment for the carcinomatous metastases of the axillary lymph nodes. (BBB)

11721 THE POST-IRRADIATIONAL RECOVERY OF YEAST CELLS WHICH HAVE BEEN IRRADIATED UNDER AEROBIC AND ANAEROBIC CONDITIONS. V. S. Barsukov, O. V. Malinovskii, and N. M. Mityushova (Pavlov Inst. of

Physiology, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 153: 1199-1201(Dec. 11, 1963). (In Russian)

A suspension of yeast cells from a three-day culture of Sacch. cerevisiae (a tetraploid strain 16 × 32 aa αα) were irradiated at 4°C with Co^{60} at a dose rate of 1100 rads/min. The concentration of yeast cells was 2.5×10^8 cells/ml under aerobic conditions, and 2.5×10^7 cells/ml under anaerobic conditions. After the irradiation, the suspension of yeast cells was diluted to 200 to 250 cells/ml, and the survival of yeast cells was determined by counting colonies on agar, after holding the yeast cells in water for a period of 0, 4, 8, 12, 16, and 20 hours. The results show that the rate of recuperation, and the survival of the yeast cells are not affected by the presence of oxygen. No difference in genetic damage can be distinguished that is due to the presence of oxygen. (TTT)

11722 THE EFFECT OF THE RADIATION INACTIVATION OF NUCLEI ON THE SYNTHESIS OF INFORMATION RIBONUCLEIC ACID IN THE EMBRYOS OF GROUNDLING FISH (MISGURNUS FOSSILIS). N. V. Belitsina, L. P. Gavrilova, A. A. Neifakh, and A. S. Spirin (Bakh Inst. of Biochemistry, Academy of Sciences, USSR and Severtsev Inst. of Animal Morphology, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 153: 1204-6(Dec. 11, 1963). (In Russian)

A dose of 10 to 100 kr of radiation on the embryo of a fish arrested its development. The fish embryo was incubated with adenine, guanidine, and uridine tagged with C^{14} in order to determine which fraction of the nucleic acids was affected by the irradiation. The nuclei acids were separated chromatographically. The fish egg was given an x-ray dose of 50 kr, and was incubated with adenine, guanidine, and uridine tagged with C^{14}. The synthesis of DNA was completely curtailed by the irradiation. The distribution of RNA with a low molecular weight became more uniform with irradiation. Even though the synthesis of DNA was completely stopped by the irradiation, the synthesis of m-RNA having a high molecular weight was not affected at all. It was concluded that m-RNA is not directly connected with the transmission of genetic information from the cell nucleus to the cytoplasma. (TTT)

11723 EFFECTS OF IONIZING RADIATIONS ON THE MITOTIC ACTIVITY AND DEOXYRIBONUCLEIC ACID OF FIBROBLASTS CULTIVATED IN VITRO. Ch. M. A. Kuyper, S. Liebecq-Hutter, and S. Chevremont-Comhaire (Université, Liege). Exptl. Cell Res., 28: 459-79(1962). (In French)

Effects of x rays were studied on chick embryo fibroblasts cultivated by the hanging drop method, using hard, soft, and half-soft x rays (200-100 kv) and a dose of 400 r. With hard (200-kv) x rays only, 2 different rates were used for 400 r, and effect of other doses (100, 200, and 800 r) was compared. Growth was studied by mitotic index and surface area measurements, for times up to 14 hours after irradiation, on fixed cells. DNA content was estimated in individual nuclei by cytophotometry after Feulgen staining. Incorporation of tritiated thymidine was studied by autoradiography for different periods after irradiation of fibroblasts cultures. Mitotic activity was suppressed immediately under all conditions of irradiation. After 400 r, mitoses took place again four hours after hard rays, eight hours after soft rays, and no longer after half-soft rays. Rates of irradiation had no influence (30 or 200 r/min at 200 kv). The percentage of nuclei with a DNA content between two and four units, corresponding to diploid and tetraploid nuclei, was increased during the first four hours after irradiation and nearly fell to zero 12 and 14 hours after irradiation. Histograms were normal and were comparable with controls; neither the quality nor intensity of x rays seemed to influence the results. After 800 r, there were no more values between two and four units DNA but tetraploid values decreased 15 hr after irradiation, which was interpreted as an inhibition of the synthesis. During the first four hours after irradiation at 400 r, the mean value of DNA, estimated for 100 nuclei was increased and reached 150% of the controls. It then decreased gradually and was comparable to controls at 12 and 14 hours after irradiation. Neither quality nor intensity of x rays influenced these results. The effect was proportional to dose up to 400 r. Tritiated thymidine was incorporated into more nuclei during the first two hours after irradiation; during the following hours, less nuclei synthesized DNA. Incorporation of tritiated thymidine in irradiated nuclei (number of grains per nucleus) was less than in controls. The moderate dose of 400 r permitted demonstration of the effect of x rays on cells which were in the presynthesis stage. These cells initiate DNA synthesis earlier than without irradiation. However, the DNA which synthesized under these conditions may be abnormal and cells which have produced this DNA may disappear afterwards. (BBB)

11724 RUPTURE OF THE CAROTIDS FOLLOWING RADICAL NECK SURGERY IN RADIATED PATIENTS. Steven J. Borsanyi (Univ. of Maryland, Baltimore). Eye, Ear, Nose Throat Monthly, 41: 531-3(July 1963).

Rupture of the common carotid artery following radical neck surgery for malignant head and neck tumors is not an unusual complication, but it is more frequent when radiation and surgery are performed in combination. Some new concepts and techniques which might help to eliminate or lower the incidence of carotid artery rupture following surgery and irradiation are reviewed. Several factors are responsible for the rupture of the carotids in irradiated patients who also undergo surgery. The decreased vascularity of irradiated tissue due to the obliterating endothelial thickening in the blood vessels and changes in the connective tissue are well-known. This decreased blood supply is also responsible to a larger extent for the prolonged healing time of irradiated tissue. Recent investigations show that the healing time in neck dissection following up to 5000-r irradiation was prolonged 59%. Another contributing factor in the rupture of the carotids is the greatly diminished blood supply of the carotids themselves following radical neck surgery. Since the adventitia is removed during neck dissection, the nourishment of the artery is dependent mostly upon the skin flap. Since rupture of the common or internal carotid arteries is almost always associated with irradiation, preoperative planning can greatly reduce the incidence of arterial rupture. Recently, treatment in irradiated patients is being directed toward prevention of complications. Some surgeons advocate raising a flap at the time of neck dissection, and if necessary, sacrificing the radiated skin. If the skin is not sacrificed, the flap is sutured back to place and kept in reserve. Or, the levator scapulae may be divided muscle inferiorly, then brought across the carotid bulb, and attached to the strap muscles anteriorly to improve the nourishment of the common carotid. Blood pressure in the internal carotid artery should be measured during the surgical procedure, and if the pressure drops significantly, anastomosis of the internal carotid artery to the ipsilateral external carotid artery carried out. A flap should be made immediately, if flap necrosis should occur, to cover the carotids. The flap should not include radiated skin. Chest flap based at the shoulder has been used successfully, as have large shoulder

flaps based superiorly at the mastoid and occipital region. Skin should not be used for flap where there is likelihood of recurrence of tumor. Ligation of the carotids following radiotherapy should be reserved only for patients with massive rupture or invasion by cancer in the presence of necrotic, infected tissue bed, lack of skin for replacement and oral fistula. In all other patients, resuturing, free vascular grafting, ipsilateral anastomosis of the internal carotid artery to the external carotid artery, or pedicle flap transfer should be carried out, depending on the indications. (BBB)

11725 DETECTION OF RADIATION INJURY ON THE BASIS OF CHANGES OF CERTAIN CHARACTERISTICS OF THE BLOOD. Sándor Gyoergyi, József Gazsó, and János Nagy (Inst. of Medical Physics, Budapest). Fiz. Szemle, 13: 216-18(July 1963). (In Hungarian)

The number of persons who may be exposed to the effects of ionizing radiation continues to increase in view of the accelerated development of nuclear energy and application of isotopes in medical, agricultural, and industrial research. In the absence of exact dosimetric measurements, the absorbed dose must be estimated from biological changes. Thus, the discipline of biological dosimetry was developed; it is based primarily on observations of changes in the properties of the peripheral blood. The observed effects must be critically evaluated because other factors may play a role. The radioinduced primary ionization activates the water molecules; the thus-formed chemically active compounds and free radicals are responsible for the injury. The tests were carried out on albino rats exposed to a 10 r/min Co^{60} source for whole-body irradiations ranging from 25 to 500 r. The exposed animals were subjected to erythrocyte and thrombocyte determinations. Ultrasonic tests were also made; the ultrasound-induced damage was found to be more marked with the blood of animals exposed to radiation. The resistance of the erythrocytes was not affected but a dose dependence was observed in the resistance of the thrombocytes. The coagulation time of the blood decreased markedly with increasing total dose. It was also noted that the activity of the thrombocytes increased with the dose while the activity of the other blood components decreased. (TTT)

11726 THE RESULTS OF CERVICAL CARCINOMA TREATMENT IN THE STUTTGART LANDESFRAUENKLINIK 1950-1957, WITH SPECIAL CONSIDERATION OF URETERAL COMPLICATIONS. H. Hartmann (Landesfrauenklinik, Stuttgart). Geburtsh. Frauenheilk., 23: 832(Sept. 1963). (In German)

Results of and complications occurring from the surgical and (or) radiation treatment of 506 women with uterine cervical cancer are reported. In only two of 60 patients in which intravenous pyelograms were conducted were ureteral complications detected, and it is suggested that irradiation methods, as they are carried out at this clinic, only rarely lead to ureteral injury. The radiotherapy plan at this clinic for cervical carcinoma includes the implantation of Ra three times intracervically and 20 fractionated percutaneous 200-kv x-ray treatments (over 4 fields of 10 × 15 cm at a skin focus distance of 40 cm for parametrial doses of 1500 to 1800 r). The x-ray treatments are given in the intervals between Ra implantations. (BBB)

11727 EFFECTS OF RADIOTHYROIDECTOMY ON THE HYPOPHYSIS OF THE EEL. DISCUSSION ON THE PARA DISTALIS OF TELEOSTS. Madeleine Olivereau (Institut Oceanographique, Paris). Gen. Comp. Endocrinol., 3: 312-32(June 1963). (In French)

Of 25 silver male eels (Anguilla anguilla) injected with high doses (750-2240 μC) of radioiodine (I^{131}), complete thyroid destruction was achieved in four. The total doses in the four cases were 750, 1000, 1000, and 2240 μC, given in three divided doses several months apart. The number of remaining thyroid follicles at each dose level is tabulated. In the pituitary there was hypertrophy and hyperplasia of thyrotropic cells which became completely degranulated and vacuolated. Nuclear and nucleolar hypertrophy occurred simultaneously. Erythrosinophilic cells were stimulated and partly degranulated. Both of these cell types are localized in the rostral region of the pars distalis of the teleost pituitary. The orange G positive cells and the still undifferentiated gonadotropic cells located in the caudal region of the pars distalis were not modified by radiothyroidectomy. These reactions are compared with data collected from other species. (BBB)

11728 ORIGIN OF REPEATS IN DROSOPHILA CHROMOSOMES. H. Slizynska (Univ. of Edinburgh). Genet. Res. (Cambridge), 4: 154-7(1963).

From the point of view of evolution, repeats (Rp) are the most important category of structural changes, and are assumed to provide a mechanism for the evolution of genes with new functions. An estimation of the frequency with which Rp's occur and an attempt at an understanding of the mechanism by which they originate are therefore undertaken. Rp, a type of duplication where a segment of one chromatid is inserted next to its homologous segment in the sister chromatid, are induced by x rays at a very low frequency and some chemical mutagens are capable of inducing Rp's with a high frequency. Attempts were made to deduce the mechanism responsible for the origin of Rp's from a cytological study of different types of Rp and their relative frequencies, based on x-ray and formaldehyde-induced Rp's in Drosophila melanogaster. Four types of Rp were found during cytological analysis of the effects of formaldehyde food, and all can be explained by a mechanism which requires two breaks in a still undivided chromosome; after splitting of the chromosome, these breaks result in two pairs of isochromatid breaks. Depending on the type and the number of new rejoinings, different types of Rp are formed. All of them are accompanied by the same complementary deficiencies (Df). In order to result in a Rp with complementary Df, the breaks have to fulfill special conditions. They have to be available for reunion at a time when sister chromatids are closely apposed to each other, and they must affect both chromatids at the same level. For the latter condition to arise from "hits" on the already separated chromatids would require a highly improbable coincidence, especially for a chemical mutagen. On the other hand, it would follow automatically from a previous hit on the still unsplit chromosome, if the broken ends remained available until chromatid separation. Observations on x-irradiated chromosomes show that such a delay in reunion is rare, at least for x-ray-induced breaks. Although breaks induced in spermatozoa of Drosophila remain available until after fertilization, they then rejoin quickly and usually before chromosome splitting, as shown by the rarity of chromatid changes, in particular of Rp's. This applies equally well to x-ray-induced breaks in premeiotic chromosomes, which hardly ever persist long enough to give Rp's a meiotic prophase. The frequency with which Rp's rise de novo without treatment is not known. In Drosophila, it is very low, but Rp's are detected only when accompanied by a dominant visible effect, e.g., duplication Bar in D. melanogaster. X rays are capable of producing Rp's but with a very low frequency (2-6.5% of all changes)

compared with other structural changes induced simultaneously by the same treatment. Chemical mutagens, on the other hand, produce Rp's with a much higher frequency than other kinds of structural change. The relative frequencies of formaldehyde-induced types of change are as follows: Rp's 35.3%, Df's 25.0%, translocations 17.7%, inversions 17.7%, other changes 4.3% of all changes. It is concluded that most or all repeats arise from actual chromosome breaks, which subsequently give rise to sister chromatid breakage followed by new rejoinings. A proposed model for the origin of repeats suggests that these may arise most readily from chromosome breaks which remain latent (potential) until separation into sister chromatids. This is in excellent agreement with the fact that formaldehyde, which produces mainly potential breaks, yields a high frequency of Rp's, while x rays yield very few. (BBB)

11729 LUNG CANCER FROM RADIOACTIVE CERIUM CHLORIDE. H. Cember and K. Stemmer (Univ. of Cincinnati). Health Phys., 10: 43-8(Feb. 1964).

Soluble Ce^{144}, as $Ce^{144}Cl_3$ solution, was found to be a pulmonary carcinogen when intratracheally injected into rats in doses of 10, 15, or 30 μC per rat. The tumor frequency in each of the treatment levels was 9/61, 31/52, and 27/37, respectively. The first death due to lung cancer, a squamous cell carcinoma, was a rat that died 70 days after exposure to 30 μC. No tumors were found among twenty-one control rats, and no bone cancer or primary liver cancer was found among any of the experimental rats. (auth)

11730 THE EFFECT OF 5-HALOGENATED DEOXYURIDINES ON THE FREQUENCY OF X-RAY-INDUCED CHROMOSOMAL ABERRATIONS IN VICIA FABA. B. A. Kihlman (Uppsala Univ.). Hereditas, 49: 353-70(1963).

The effects of 5-fluorodeoxyuridine (FUdR) and the thymidine analogs 5-chlorodeoxyuridine (CUdR), 5-bromodeoxyuridine (BUdR), and 5-iododeoxyuridine (IUdR) on the frequency of x-ray-induced chromatid aberrations in the root tips were studied. Pretreatments with CUdR, BUdR, and IUdR at concentrations of 100 μM increased the effect of a given dose of x rays by factors of 1.3, 1.6, and 1.9, respectively. IUdR increased the frequency of x-ray-induced aberrations to the same extent whether the roots were irradiated under anaerobic or aerobic conditions. For maximum enhancement, it was necessary to treat the roots for at least 24 hr with the thymidine analogs. Post-treatment with IUdR did not influence radiosensitivity. When x irradiation was combined with a FUdR treatment, and the effect was scored in anaphase, the number of fragments was markedly increased and the number of bridges was decreased, in comparison with the x-ray control. The FUdR treatment was equally effective when given after as when given before and during irradiation. The results show that the frequency of x-ray-induced chromatid aberrations in the root tips of Vicia is influenced in the same way by these 5-halogenated deoxyuridines as is the killing effect of x rays on mammalian cells in tissue culture and on bacteria. When the thymidine analogs were tested in equimolar concentrations in Vicia IUdR was the most effective and CUdR the least effective. The difference in effectivity could be a result of a different incorporation of the analogs into DNA. The fact that a 4-hr pretreatment with IUdR resulted in an increased frequency of aberrations only when the roots were fixed between 9 and 15 hr after irradiation indicates that only those cells which were undergoing DNA synthesis when exposed to IUdR were sensitized. This is consistent with the idea that incorporation of IUdR into DNA is necessary for sensitization. The fact that thymidine and its analogs can reverse or prevent the chromosome damage produced by the deoxyuridine analog FUdR is consistent with the idea that the effect of FUdR on chromosome structure is a result of its inhibitory effect on the synthesis of thymidylic acid. The experiments have further shown that whereas FUdR-induced thymidine deficiency produces fragmentation of chromosomes, the incorporation of thymidine analogs, such as CUdR, BUdR, and IUdR, into chromosomal DNA does not itself, as a rule, cause chromosomal aberrations, but it makes the chromosomes more sensitive to the chromosome-breaking effect of x rays. It is concluded that the stability of the chromosome is dependent on the composition and state of its DNA, favoring a hypothesis of chromosome organization which allots to DNA an important function in keeping the chromosomes intact. (BBB)

11731 INDUCTION OF WAXY MUTANTS IN MAIZE BY ACUTE AND CHRONIC GAMMA IRRADIATION. Goesta Eriksson (Univ. of Stockholm). Hereditas, 50: 161-78 (1963).

Two maize strains homozygous for the Wx allele were treated by acute or chronic gamma irradiation from a Cs^{137} source and the frequencies of waxy pollen grains were analyzed. The dose rates used in the chronic experiment varied between 5 and 200 r/day. The acute treatment was carried out for two hours around prophase I of the pollen mother cells. The doses used were: 3, 6, 12, 25, 50, 100, 200, and 400 r. The low dose rates (5-78 r/day) of the chronic treatment gave a linear relationship between dose rate and mutation frequency, whereas the high dose rates (109-200 r/day) gave an exponential relationship. The acute treatments gave mutation frequencies appreciably higher than the spontaneous mutation rate. The mutation rates of 0-200 r showed a linear dose effect regression. The data of the whole dose range (0-400 r) could be fitted to a curvilinear regression. The lower doses might have induced mutations by one-hit events, whereas the dose of 400 r might have induced additional mutations by two-hit events. It is strongly indicated that low doses (3-12 r) give a higher mutation frequency than expected from the frequencies at 0 r and doses $\geq$50 r. (auth)

11732 PRODUCTIVE MUTATIONS INDUCED IN BARLEY BY IONIZING RADIATIONS AND CHEMICAL MUTAGENS. Åke Gustafsson (Dept. of Forest Genetics, Stockholm and Swedish Seed Assn., Svalöf). Hereditas, 50: 211-63(1963).

A series of yield trials are discussed dealing with the grain production of 123 induced mutations in Bonus barley and 74 induced mutations in Foma barley tested 1955–1962. Of the induced mutations 21 out of 123 and 47 out of 74, respectively, were induced by chemical treatments (mostly ethylene oxide and ethyleneimine). The practical aims of the mutation work in Bonus barley were from the beginning defined in a precise manner, to increase lodging resistance and earliness, with a maintenance of the high yielding ability of the mother strain. The aims were realized. One lodging-resistant high-productive mutation (erectoides-k^{32}) and a very early productive mutation (early-α^{8}) were induced and finally released. The theoretical purpose of the yield trials was to compare the yielding ability of radiation-induced and chemically-induced mutations. There was no general difference between the two groups of mutations: 50 per cent of the radiation-induced and 38 per cent of the chemically-induced mutations in Bonus produced approximately as much as the mother variety under optimal conditions. In Foma barley the corresponding figures, although preliminary, were 33

and 38 per cent. With regard to the average yield of erectoides mutations there was certain difference between radiation and chemically-induced mutations of both varieties, probably connected with a preferential origin of c-erectoides in radiation experiments. (auth)

11733 ARE THERE REAL STOCK DIFFERENCES IN X-RAY INDUCED MUTABILITY IN DROSOPHILA MELANOGASTER? Oeistein Stroemnaes (Univ. of Oslo, Blindern, Norway). Hereditas, 50: 264-8(1963).

Literature on the type and frequency of radioinduced mutations in Drosophila is reviewed with particular reference to the variations found among various strains. (H.M.G.)

11734 STUDIES OF IRRADIATED MOUSE POPULATIONS. II. DOMINANT EFFECTS ON PRODUCTIVITY IN THE 4th-6th GENERATION. K. G. Luening (Lab. of Radiation Genetics, Stockholm). Hereditas, 50: 361-76 (1963).

The effects upon the productivity are presented from the 4th, 5th and 6th generations of a mouse population given 276 r of x rays to spermatogonia each generation as compared with a parallel control population. There is no detectable effect with regard to the number of dead or sterile during the test period of 170 days. There is a very slightly lower number of litters in the irradiation series, while the litter-size shows a consistent reduction independent of the number of litters produced by the females. Slightly more litters are completely lost in the irradiation series than in the control. The sex-ratio is not affected. The rate of death between birth and weaning in litters with at least one weaned depends upon the mother in such a way that females that have lost one or more litters completely had, in surviving litters, a higher death rate than females that kept all litters. Only in the former group is there a significant effect from irradiation while in the latter the difference is insignificant but both are in the direction of a higher death rate in the irradiation series. The fallacies in conclusions drawn from experiments of this kind as regards the hazards of irradiation are discussed. (auth)

11735 LIVER AUTOANTIBODIES IN THE RAT. D. M. Weir (Univ. of Edinburgh). Immunology, 6: 581-91(Nov. 1963).

Thirty rats were given a dose of 600 r followed within 2 hours by the subcutaneous injection of 0.03 ml CCl_4 per 100 g body weight. Control groups received either irradiation or CCl_4 alone. The animals were bled on the 1st, 2nd, 3rd, 4th, 7th, 10th, and 14th days and the serums tested against the rat liver antigens in the complement-fixation test. The results showed that only those animals which had received CCl_4 alone gave positive tests. The irradiation had thus effectively prevented the serologic response normally found after CCl_4 injection. Histological preparations showed that irradiation did not prevent the toxic effect of the CCl_4 on the liver. The factor is not present in the γ-globulin fraction on cellulose column chromatography and seems likely to be a macroglobulin on the basis of its heat lability and its susceptibility to a thiol reducing agent. Failure to induce a passive cutaneous anaphylaxis reaction in the guinea pig is compatible with this. It is suggested that tissue injury results in a similar release of denatured tissue breakdown products into the circulation and subsequent antibody formation. Histological examination of rat livers after CCl_4 injections show the close relation of the presence of antibody and liver damage; a higher proportion of animals with antibody show damage on the 3rd day than have damage without antibody. However, there is no invariable correlation between damage to liver and presence of antibody. Possible explanations for animals without antibody are given. (BBB)

11736 THE ANTIATHEROGENIC EFFECT OF IRIDIUM^{192} UPON THE CHOLESTEROL-FED RABBIT. Meyer Friedman, Leland Felton, and Sanford Byers (Mount Zion Hospital, San Francisco and Univ. of California, San Francisco). J. Clin. Invest., 43: 185-92(Feb. 1964).

A 20-cm length of Ir^{192} wire was placed for 48 hours in the proximal portion of the aortas of a series of rabbits. The rabbits, when subsequently fed a diet containing excess cholesterol, failed to exhibit significant atherosclerosis, as compared to the control animals, in that portion of the aorta which received the irradiation. The histological and chemical studies performed upon these rabbits suggest that the antiatherogenic effect of the irradiation was due primarily to the suppression of the intimal hyperplastic response to a persistent hypercholesteremia usually observed in the rabbit's aorta. (auth)

11737 EFFECTS OF 300-kv X-RAY RADIATION ON SITOPHILUS ORYZAE. D. L. Hoover, E. H. Floyd, and H. D. Richardson (Louisiana State Univ., Baton Rouge). J. Econ. Entomol., 56: 584-5(Oct. 1963).

A closely related species, S. granarius, proved somewhat more resistant to the effects of irradiation than did S. oryzae. Further data showing the effects of 1000 to 12,500 r doses of x irradiation on the egg, the three larval instars, the pupal, and the adult stages of the rice weevil, S. oryzae, are presented here. No adults emerged from eggs exposed to treatment of 5000 r and greater. From eggs which had received 2500 r, the emergence represented 2.6% of normal. First-instar larvae which received 7500 r or greater failed to develop into adults. Only 1 adult out of 100 developed and emerged from a 5000 r exposure. Thirty-four adults (9.4% of the control) emerged from the 2500 r treatment and 11 of these showed physical deformities. Typical deformities observed were: colorless antennae that were often reduced in size. Adults so affected exhibited extreme difficulty in coordination of movement and balance; fused tarsal segments which lacked flexibility; twisted wings which protruded beneath the elytra; twisted elytra void of pigment; loss of ability to articulate leg segments at the joints. Many of the first-instar individuals exposed to 2500 r developed to the pupal and adult stages but died before emergence. Emergence of adults from irradiated pupae was influenced little by the dosage applied. However, the greatest mortality of adults which emerged from irradiated pupae occurred among those which had been subjected to the heavier dosages. There was only a slight increase in mortality in adults which had been exposed in the pupal stage to the lower dosages. The only abnormality observed in adults exposed to irradiation in the pupal stage was a general lack of coloration, which was directly associated with the dosage administered. Results of irradiation of 7-day-old adults showed an LD_{50} between 7500 and 10,000 r. The point of complete sterility also occurred between these levels. These data show that resistance by S. oryzae to radiation increases with the developmental stage of the insect. However, over the entire range of exposure, the pupa was the most resistant stage. (BBB)

11738 EFFECTS OF GAMMA RADIATION ON CODLING MOTH EGGS. W. S. Hough (Virginia Agricultural Experiment Station, Winchester). J. Econ. Entomol., 56: 660-3(Oct. 1963).

Radiation studies on eggs of the codling moth (Carpo-

capsa pomonella) were initiated to learn if this approach might be used to influence response of the insect to insecticides. The radiation effects on hatchability, life history of the progeny through several generations, and susceptibility of the larvae to insecticides are reported. The eggs were exposed to Co^{60} γ radiation to establish a strain designated Va.-GR. Most of the eggs were four days old when irradiated. During each of the next four seasons the Va.-GR strain was reared through two generations on unsprayed apples. Principal effects on biological performance were: temporary increase in incubation period of the egg; increase in average number of eggs deposited by Va.-GR females; and slight increase in longevity of Va.-GR moths. Sensitivity to γ rays declined with aging of the eggs. Susceptibility to DDT and lead arsenate was not altered by irradiating eggs four days old, but an increase in DDT resistance followed irradiation of Va.-GR eggs less than one day old. Susceptibility to weak concentrations of Guthion (O,O-dimethyl-S-(4-oxo-1,2,3-benzotriazin-3-(4H)-ylmethyl)phosphorodithioate) or Sevin (1-naphthyl-N-methyl-carbamate) was not affected. Fortifying DDT with antiresistant compound did not influence resistance of Va.-GR larvae to DDT. Adding Bakthane, a wettable powder containing Bacillus thuringensis, to DDT did not eliminate the apparent difference between the strains in 1962 but in the case of the parent strain (Virginia) larvae toxicity was reduced. Inasmuch as the two strains were reared in the same manner on unsprayed apples and were subject to similar environmental factors, resistance to DDT by the Va.-GR strain can be attributed only to selective action of γ rays on young eggs; that is, eggs not exceeding 24 hr old. The same dosage on young eggs of the same brood did not select for resistance to weak concentrations of Guthion or Sevin insecticides. Selection for DDT resistance in the young eggs but not in eggs four days old may be explained by assuming that the cells from which the DDT-resistant mechanism is derived are more sensitive to γ rays in the young eggs than in embryos that are formed. Duration of effects of selective γ radiation on codling moth eggs is not known, but increased length of the egg stage appeared to be temporary. Such effects as increased egg production and increased longevity of the female moths were manifested through six generations. On the other hand, increased life span of the male moths was no longer evident in the sixth generation. (BBB)

11739 MALFORMATION OF THE EXTREMITY IN THE MOUSE FETUS CAUSED BY X-RADIATION OF THE MOTHER DURING PREGNANCY. Ujihiro Murakami, Yoshiro Kameyama, and Hiroshi Nogami (Nagoya Univ., Japan). J. Embryol. Exptl. Morphol., 11: 549-69(Sept. 1963).

Mice were exposed to x radiation of 300, 200, and 150 r from the 8th to 13th day of pregnancy. X rays were produced by a therapeutic x-ray machine of 172 kvp, 10 ma, at 16 r/min. In offspring from mothers treated on the 11th day, malformations of the extremities were observed in groups treated with over 200 r. In offspring from mothers treated on the 12th day, digital reductions, on account of ectrodactylias, were the typical malformation in the fore-limb. In the hind-limbs, the incidence was a little lower and the predominant site of involvement was the third digit. Other digital malformations occurred more often in the hind-limb than in the fore-limbs, though not frequently. The formation of ectrodactylias after x irradiation was studied in a follow-up experiment. The process began with cellular necrosis in the hand and foot plate corresponding to the predominant site of ectrodactylias, chiefly in the second digit of the fore-limb and in the third digit of the hind-limb. The process may damage the precursor of the precartilage. In contrast to the regenerative neural tissue, compensation does not take place in the mesenchymal tissue once the destruction is severe, and the reduction of digits will therefore persist. The effect of x radiation upon a developing digital primordium may be a directly destructive process. The critical stage for extremity malformations due to thalidomide in human beings corresponds with the critical stage for x-ray malformations of the extremities in mouse. The pattern of malformations caused by x radiation was also found to be similar to that produced by riboflavin deficiency, but with some additional skeletal changes such as humero-radial synostosis. (BBB)

11740 THE POSTNATAL GENESIS OF CEREBELLAR DEFECTS IN THE X-IRRADIATED MOUSE. R. Schmidt (Universität, Halle-Wittenberg, Ger.). J. Hirnforsch., 5: 163-209(1962). (In German)

The postnatal genesis of cerebellar defects in irradiated mice was studied. The experimental animals received a dose of 800 r of x radiation on the day of birth. At only four hours after irradiation, numerous pyknotic cells were observed in the granular layer and mantel zone. The embryonal granular layer seemed to be especially sensitive to radiation, for only a few cells of this stratum survived the radiation treatment. The radiation defects of the granular layer and mantel zone lead to severe histotectogenetic derangements in the cortex: the structure of the stratum granulosum internum did not develop further. The Purkinje cells were distributed heterotopically over the entire cortex, without formation of a typical molecular stratum. Extending from small foci in several lobes (posterior lobe, cerebellar hemispheres) surviving embryonal granular cells initiated the repopulation of the embryonal granular layer. In this way normalization of the histogenetic processes was effected in these regions. The migratory cells from the partially regenerated embryonal granular layer produced an incomplete repair of the cortical radiation damage. The reparative processes resulted only from the embryonal granular layer. In the cerebellar lobes where the granular layer is not regenerated after the radiation insult the histotectonic organization of the cortex was generally unchanged. The Purkinje cells, the cerebellar nucleus, the choroid plexus, as well as the cerebellar brachia showed no changes, since they were essentially differentiated before the irradiation. Possible radiation injuries to the glia and the cerebellar medula or nerve fibers were not studied. The effect of x radiation on lobulation of the cerebellum was studied. Development of the cerebellum stopped several days after the radiation exposure. Lobulation of the extraventricular surface made no additional progress. All sulci and lobuli were absent. In the vermis and hemispheres shallow sagittally oriented grooves appeared during the repair period. (BBB)

11741 ENERGY-PRODUCING METABOLISM OF THE SKIN FOLLOWING X IRRADIATION. J. Rodesch and P. Mandel (Institut de Chimie Biologique, Faculté de Medecine, Strasbourg). J. Physiol. (Paris), 55: 330-1(Mar.-Apr. 1963). (In French)

The effects of a single dose of 700-r superficial irradiation on O_2 and glucose consumption and on lactic acid production in rat skin was studied during a period of 1 to 21 days. Adult rats of the same sex and similar weights were used. In control rat skin O_2 consumption was 133 ± 18.3 ml/g wet wt/hr, glucose utilization 0.38 ± 0.052 mg/g/hr, and lactic acid production 0.105 ± 0.020 mg/g/hr. On an average, 43.5% of glucose was utilized aerobically,

27.9% anaerobically, and 24.6% came from other sources. Irradiation progressively lowered the consumption of O_2 and glucose over the 21-day period, also the production of lactic acid from the 4th to the 7th day. By the 10th day, values were similar or slightly higher than in the control animals. This increase in values was confirmed on the 14th day, with a return to the normal by the 20th day. Thus aerobic glycolysis decreased by 22% between the 2nd and 4th day and anaerobic glycolysis by 30% on the 3rd day. It was concluded that, as glycogen and fatty acid syntheses appear to decrease as an effect of irradiation, the pentose-phosphate shunt may be likewise affected, with an accompanying accumulation of intermediate metabolites followed by blocking of various steps in intermediary metabolism of glucose. In other experiments, in which the epidermis was separated from the dermis following irradiation, diminished O_2 consumption of the epidermis could be demonstrated, showing that both layers of skin are involved in the impaired energy metabolism after exposure to radiation. (BBB)

11742 RADIATION NEPHRITIS IN ADULTS AND CHILDREN: EFFECTS OF RADIATION ON GROWING BONES. Michael P. Westfall (Veterans Administration Hospital, Bronx, N. Y.). J. Urol., 85: 476-81(Apr. 1961).

With the increasing use of megavoltage radiation therapy, malignant tissues and adjoining normal structures deep within the body are being subjected to much higher doses of radiation than was previously possible with orthovoltage techniques. To evaluate this problem, two groups of patients were compared to determine what effects x radiation had upon the kidneys of adults and the growing spine and kidneys of children. The groups were adult males (66) given radiation therapy to the upper and lower abdomen and the inguinal regions in the treatment of testis tumors, and children (15) with Wilms tumor surviving more than 1 yr after radiotherapy was administered to the corresponding renal fossa. In 23 adult cases (34%), urinary abnormality or hypertension developed following radiotherapy after a latent period varying from 1 month to 1 yr. In the children irradiated, abnormal urinary findings subsequent to irradiation and nephrectomy developed in 5 (33%), after a latent period of several months to a year. Radiation injury to growing bones developed in two children (11%). This complication became manifest only after a latent period of more than a year. The literature relating to clinical and experimental aspects of renal radiation injury is discussed, and findings in previous clinical reports are compared with the present findings. (BBB)

11743 EMBOLIZATION OF DOG PROSTATES WITH YTTRIUM-90 MICROSPHERES. Warren M. Greene (Univ. of Rochester, N. Y.). J. Urol., 90: 451-7(Oct. 1963).

Experiments exploring means for the protection of adjacent normal tissue while delivering a destructive dose of radiation to malignant tissue were conducted. By injection of radioactive ceramic spheres or particles, too large to pass through capillaries or arteriovenous shunts, relatively high doses of radiation can be distributed homogeneously to a circumscribed area. Attempts were made to determine the uniformity of distribution and the radiation effect of varying doses of spheres injected into the arterial supply of the dog prostate. Nonradioactive and radioactive ceramic microspheres of 60 μ dia were used since this size exceeds the diameter of capillaries and arteriovenous shunts. Yttrium-90 microspheres of varying radioactivity were used. Doses injected into right and left hypogastric arteries varied from 0.69 to 28.4 mc/side (92-1260 mc/g prostate). Homogeneous distribution of radioactivity within the prostate was demonstrated by autoradiography. Distribution to some other organs (rectum, penis, and bladder) occurred because arterial supply to these structures was not isolated and occluded. The amount of radioactivity found in the lungs suggested more venous drainage in some cases than seemed apparent, and because of the infarctions of pelvic organs may have leaked radioactive spheres into the venous circuit. In 6 of the 8 dogs which died prematurely (2 to 7 days after surgery) obvious infarction of the prostate and in some other pelvic structures had occurred. That the radioactivity contributed to the infarction is suggested by the results in the dogs which received large doses of radioactivity (18.9 and 28.4 mc per side) in minimal amounts of spheres (100 to 150 mg per side). The intensely concentrated radioactivity within the arteriolar lumens may have caused vasculitis and subsequent thrombosis. Although homogeneous destruction of the prostate gland occurred, the effect of a given dose ranged unpredictably through three groups: no apparent effect at all, destruction of the prostate, and early death with infarction of the prostate and other pelvic organs. It was concluded that with the present technique the range between the dose of radioactivity which caused no obvious response and the dose which is related to acute death is too narrow to allow reasonably predictable results, but that further refinement of technique might increase control over tissue destruction. (BBB)

11744 EFFECTS OF ROENTGEN IRRADIATION ON THE APPEARANCE OF AN ULTRA-VIOLET LIGHT-INDUCED THROMBOPOIETIC SERUM AND ON THE EFFECTIVENESS OF THIS FACTOR IN MOUSE EXPERIMENTS. Istvan Cserhati, Ferenc Krizsa, Ervin Soevenyi, and Kalman Rak (Orvostudományi Egyetem, Szeged). Kiserl. Orvostud., 14: 86-90(Mar. 1962). (In Hungarian)

Uv treatment was conducted on 20-g mice with a Hanau-type quartz lamp, operated at 210 v and 5.2 a, at a 50-cm distance for 30 min. To investigate the influence of ionizing radiation on development of this factor, some mice also received whole-body x irradiation with 300-r doses. Serum was transferred into tail vein of recipient mice in 0.2-ml amounts. Thrombocyte counts of normal recipient mice were determined on the 6th day after uv treatment, and x-irradiated mice were checked on the 10th day postirradiation. Serum obtained 24 hr post uv treatment raised the thrombocyte count of normal mice 55%; however, x-irradiation immediately following uv treatment reduced the increase to 20% or less. Previous studies showed that thrombocytopenia is most pronounced on the 10th day postirradiation; therefore, uv treatment was applied on the 9th day and serum was taken on the following day and injected into normal recipients. No substantial increase was noted in the thrombocyte count. If uv treatment preceded x irradiation by 24 hr and serum was transferred immediately, the increase was ~30% in the thrombocyte count. In this case the uv-induced factor was already present in the blood of the donor mice. The x-irradiated mice without further treatment showed a 61% decrease in the thrombocyte count on the 10th day, but if uv treatment preceded x-ray treatment by 24 hours, a 20% increase was seen. If uv serum were given immediately after x irradiation the thrombocyte count remained steady and thrombocytopenia was prevented. X-ray-induced thrombocytopenia was best prevented by uv serum given on the 5th day. The mice tolerated both treatments well. A humoral factor thus appears to be responsible for uv-caused thrombocytosis. It is apparent too that x-ray sensitive organs or tissues are responsible for the factor causing thrombocytosis, pre-

sumably principally the megakaryocyte system of the bone marrow. (BBB)

11745 THROMBOCYTOSIS-PRODUCING EFFECTS OF SERA FROM SPLENECTOMIZED AND ROENTGEN-IRRADIATED MICE IN INTACT MICE. Kalman Rak, Ferenc Krizsa, and Istvan Cserhati (Orvostudományi Egyetem, Szeged). Kiserl. Orvostud., 14: 212-16(Apr. 1962). (In Hungarian)

Two series of tests were conducted to see if the thrombocyte count of normal mice could be influenced by injecting them with serum obtained from mice in which the thrombocyte count had increased because of external influences. In one instance the count was increased by splenectomy, in the second group because of a large dose of x irradiation. The mice received 500-r whole-body doses of 180 kv x rays at a dose rate of 32.3 r/min. For examination of the trypsin sensitivity of the serum factor, 10 μg/ml trypsin was added to serum, which was incubated for 30 min at room temperature. Heat sensitivity was examined at 56°C with a 30-min incubation period. Serum taken at 48 and 72 hours from splenectomized donors increased the thrombocyte count of normal mice 50 and 48%; sera obtained before and after these times were ineffective. X irradiation increased the donor mice thrombocyte count to ~50,000 on the 10th day postirradiation, and it showed an increasing tendency after that. Serum obtained on the 10th day and injected into normal mice increased the count 50%, but serum obtained after that time (14th day) did not substantially influence the thrombocyte count of normal mice. Serum obtained on the 5th day postirradiation caused a 36% decrease in the thrombocyte count in normal mice. In both series of tests it was noted that thrombopoietic serum activity occurred in the treated donor mice before an increase in the thrombocyte count was noted. The question is raised whether the protein-like serum factor is a cause or a result of the observed thrombocytosis. (BBB)

11746 FRACTURES OF THE FEMUR NECK RESULTING FROM RADIATION DAMAGE. H. Koschitz-Kosic (Universitätsklinik der Charite, Berlin). Klin. Med. (Vienna), 16: 277-83(June 1961). (In German)

Fractures of the neck of the femur following radiation therapy may involve three interrelated factors: age of the patient, archetectonic phylogenesis of the femur neck, and onset of radionecrosis. Up to now ~144 cases of femur neck fracture have been reported in the literature. Of the 10 cases reported here there was no clear relation between the time of irradiation and the fracture. One fracture followed 35 months after 17,400 r, and another 15 months after 4000 r of x ray, but both of these patients had also received Ra therapy. The average time span between irradiation and fracture was 21 months. Only x ray had been given to five patients, but five had received combined x-ray and Ra treatment. One of the patients with a medial femur neck fracture became ambulatory after three weeks bed rest. The other nine fractures were nailed without any fatality. Subsequently, two cases were practically free of difficulties 12 and 18 months later, three cases exhibited slight fatigue 2, 5, and 63 months later, and five cases limped and required a cane 1, 3, 14, 17, and 76 months later. So far none of the nails have been removed. In no case was there complete recalcification of the fracture, and the ability of the ambulatory patients to walk depended on a combination of callus formation and the support of the nail. The fractures never gave any contraindication for use of the nails. Their use reduced the time for bed rest needed to an average of ~5 weeks. Treatment of this type of patient should also include appropriate geriatric and physical therapy measures. (BBB)

11747 HARMFUL EFFECTS OF DIAGNOSTIC IRRADIATION. Lancet, 1: 255-6(Feb. 2, 1963).

Recent evidence bearing on the leukemogenic effect of low doses of ionizing radiation is discussed. (BBB)

11748 HERPES ZOSTER FOLLOWING ROENTGEN IRRADIATION. Eszter Vetro (Orvostovábbképző Intézet Roentgenológiai Tanszéke, Budapest). Magy. Radiol., 15: 161-3(June 1963). (In Hungarian)

This report describes the appearance of herpes zoster in six female patients following x irradiation therapy with total doses of 1400 to 3000 r. Five of the patients received the treatment as postoperative treatment for breast cancer, the sixth patient was treated for rheumatoid arthritis. It is noted that this occurrence of herpes zoster following postoperative irradiation treatment for breast cancer is 100 times its incidence in the normal population where it occurs in an average of 0.025%. In the cases described, herpes appeared on the irradiated side of the body, in one instance it was very severe in a patient who had received prior hydrocortisone treatment, which might have accounted for the herpes in this case. It is possible that the herpes virus entered through the incision caused by the operation on the breast, although this has not been proven. The frequent occurrence of herpes zoster following irradiation is not coincidental, and further studies are under way, including measurements of radiation damage to the spinal cord ganglia. (BBB)

11749 THE PROBLEM OF THE RADIOTOXINS, DISCUSSED ON THE BASIS OF THE AUTHORS' EXAMINATIONS AND THE DATA OF THE LITERATURE. Endre Czeizel, Gyoergy Vaczó, and Pál Kertai. Magy Radiol., 15: 356-60(Nov. 1963). (In Hungarian)

The in vitro irradiated liver, muscle, red cell suspension and the irradiated blood have slightly impeded the liver regeneration of the rats. This effect is due to the radiotoxin released at the time of the irradiation of the cells and the tissues. The radiotoxin corresponds to the catabolites especially the pathological metabolites of the cells having suffered radiation damage. The accumulated metabolites may overload and eventually damage the physiological function of the organism, so for instance the division of the regenerating liver cells. (auth)

11750 THE PATHOGENESIS OF CHANGES IN THE BLOOD SYSTEM IN CHRONIC IRRADIATION. G. D. Baisogolov. Med. Radiol., 8: No. 12, 25-30(Dec. 1963). (In Russian)

An opinion is expressed on the uniformity of changes in the blood-forming tissues subjected to chronic irradiation, irrespective whether the action was local or whole-body. In all cases there occurs an intensification of destructive and secondary regenerative processes. Differences observed during bone marrow or peripheral blood investigations depend on the presence of considerable compensatory possibilities (vicarious hyperplasia of the intact bone marrow, the development of ectopic hematopoiesis) in local irradiation. In chronic irradiation the occurrence of relatively late alterations in the erythrocytic series of the bone marrow are, apparently, caused not by the lesser sensitivity of erythroblasts to ionizing radiation, but (reflecting the general biological regularity) by the prevalent differentiation of formative cells towards the erythrocytic series, as the most important in maintaining the vital requirements of the organism. (auth)

11751 INFLUENCE OF COMPLEX-FORMATION ELEMENTS ON THE VALUE OF THE TISSUE DOSE IN KIDNEYS INTERNALLY CONTAMINATED WITH RADIOACTIVE SUBSTANCES. L. A. Ilyina, T. A. Norets, G. V. Arkhangelskii, and E. I. Shcherban. Med. Radiol., 8: No. 12, 43-7(Dec. 1963). (In Russian)

The influence of complex-formation element on the value of the tissue dose in the kidney is discussed. The data of radiometric and histoautoradiographic investigations, as well as dosimetric calculations present evidence that the use of complex-formation elements accelerating the elimination of radioactive substances from the organism leads to reduction of the dose rate and the absorbed dose in kidneys. An assumption is made of causes bringing about reduction of the tissue dose in kidneys. (auth)

11752 STUDIES OF THE REGENERATION OF VESSELS IN THE SKIN WOUND AS AN OBJECTIVE METHOD OF ASSESSING CHANGES IN THE HEALING PROCESS FOLLOWING X-RAY IRRADIATION. Z. Kharvat and Yu. Shmagel. Med. Radiol., 8: No. 12, 47-50(Dec. 1963). (In Russian)

The regeneration of vessels in a healing skin defect runs three consecutive qualitatively different stages. The possibility of utilizing the latter fact as an objective criterion for the assessment of changes of the restorative process in the irradiated skin wound is discussed. A characteristic of the above-mentioned stages is given. A description of the technique and of the method of statistical treatment of the results is also included. (auth)

11753 EYE ABNORMALITIES IN MOUSE EMBRYOS AND FETUSES CAUSED BY X RADIATION OF MOTHERS: PROCESSES OF PRODUCTION IN CASE OF EXPOSURE WITH 200 r ON THE 8TH DAY OF PREGNANCY. Akio Majima (Nagoya Univ., Japan). Nagoya J. Med. Sci., 24: 171-82(Jan. 1962).

Pregnant ddN strain mice were subjected to a single whole-body x ray dose of 200 r on the 8th day of gestation. From the 11th to the 19th day fetuses were removed and examined grossly and microscopically. Fetuses on the 11th day showed complete developmental obstruction of the optic vesicle and occurrence of primary anophthalmia. On the 14th, 15th, and 17th fetal days no remnants of neural elements relating to primary anophthalmia were seen. In some cases, exencephalia with complete absence of the eye anlage, believed to be due to the extreme malformation of the brain, was noted. These presumably represent secondary anophthalmia. Some fetuses developed degenerative anophthalmia, varying from those showing remnants of the optic cup at an early embryonic stage to those developing degenerative anophthalmia at about the time of birth or severe microphthalmia. Microphthalmia was also frequently found, and this varied too from fetuses presenting an early stage of its production to those with the inner wall of the optic cup everted, malformation of the optic cup and production of infoldings, as well as those with deformities of the lens. Most of the eye abnormalities seen were cases of microphthalmia and anophthalmia but there were no cases of cyclopia and diprosopia, presumably because irradiation did not occur at a critical stage for induction of the latter anomalies. (BBB)

11754 EFFECT OF POST-IRRADIATION INCUBATION CONDITIONS ON RECOVERY BETWEEN FRACTIONATED DOSES OF X-RAYS. R. J. Berry and R. Oliver (Churchill Hospital, Oxford). Nature, 201: 94-6(Jan. 4, 1964).

Experiments were carried out to test whether recovery of mammalian cells from sub-lethal x-ray damage was dependent on the metabolic state of the cell and hence subject to alteration when the conditions of incubation between radiation exposures were altered. HeLa $S\text{-}3_{cxf}$ cells were used. The change in surviving fraction, which results when the same total dose is given in two equal fractions rather than as a single dose, is shown. Full recovery occurred if the interval between doses was 24 hr. (M.C.G.)

11755 GENETIC EFFECTS OF COSMIC RADIATION DROSOPHILA MELANOGASTER. O. S. Reddi and M. Sanjeeva Rao (Osmania Univ., Hyderabad, India). Nature, 201: 96-7(Jan. 4, 1964).

Dominant lethality was used as the measure of genetic effects of cosmic radiation on Drosophila melanogaster. Two groups of three-day-old Drosophila males were sent in plastic food cups into the stratosphere in a pressurized aluminum gondola at 8°N geomagnetic latitude to a height of about 20 miles. For the duration of 6 hr of flight, a dose of 0.18 to 0.20 mr/unit volume was received. After descent, one lot was tested for dominant lethals in 6 successive broods, while the other lot was screened for sex-linked recessive lethals and translocations. Dominant lethals were determined by hatchability tests. There was no evidence for an increased frequency of either recessive lethals or translocations. The hatchability tests, however, showed a consistent reduction in the first 3 broods of the treated series as compared with controls, while in later broods the difference became less significant and in one brood even reversed its direction. (M.C.G.)

11756 ORGANIZATION OF THE DEOXYRIBONUCLEIC ACID REPLICATING SYSTEM IN MAMMALIAN CELLS AS REVEALED BY THE USE OF X-RADIATION AND BROMURACIL DEOXYRIBOSIDE. Robert B. Painter and Ronald E. Rasmussen (Ames Research Center, Moffett Field, Calif.). Nature, 201: 162-5(Jan. 11, 1964).

Results are reported from studies of the effects of x radiation on the synthesis of desoxyribonucleic acid in HeLa and hamster cells in tissue culture. The incorporation of tritium-labeled thymidine and bromouracil desoxyriboside, an analog of thymidine, was allowed for various time periods before or after irradiation at various doses. Three different methods of DNA extraction were used. Possible mechanisms for radioinduced inhibition of DNA synthesis are discussed. The concept of a very-high molecular weight DNA is discussed in relation to the data obtained. (C.H.)

11757 LYMPHOCYTE CONTENT AND PROLIFERATIVE CAPACITY OF SERIALLY TRANSPLANTED MOUSE BONE MARROW. G. Cudkowicz (Oak Ridge National Lab., Tenn.), A. C. Upton, G. M. Shearer, and W. L. Hughes. Nature, 201: 165-7(Jan. 11, 1964).

Results are reported from an investigation of the changes in cellular composition of bone marrow of mice resulting from serial transplantation. Emphasis was placed on the capacity of the marrow and of lymph node cells to promote survival and to repopulate the spleen in lethally irradiated recipient mice. Results are compatible with other evidence that suggest that a small mononucleated marrow cell is the progenitor of the hemic cells in mice. The cell is lymphocytic in appearance but was found to be functionally different from the lymph node lymphocyte and probably not derived from the lymph node lymphoblast. (C.H.)

11758 CHROMOSOME ABERRATIONS ARISING SPONTANEOUSLY AND INDUCED IN MEIOTIC CELLS AT LOW LEVELS OF RADIATION IN TRADESCANTIA. Dale M.

Steffensen (Univ. of Illinois, Urbana). Nature, 201: 205-6 (Jan. 11, 1964).

Data are compared from an analysis of chromosome mutations arising spontaneously in Tradescantia paludosa and the frequency of micronuclei induced in meiotic cells of Tradescantia by doses of x radiation ranging from 0.3 to 6.0 r. It is suggested that the possibility of unexpectedly high meiotic sensitivity should be taken into account in setting standards for radiation tolerance for man, and particularly for the human female where immature ova remain at rest in meiotic prophase. (C.H.)

11759 RETENTION OF LABELLED DEOXYRIBONUCLEIC ACID FOLLOWING IRRADIATION: A STATISTICAL CONSIDERATION. J. L. Sanders, Glenn V. Dalrymple, and C. D. Robinette (Univ. of Colorado, Denver). Nature, 201: 206-7(Jan. 11, 1964).

The retention of desoxyribonucleic acid labeled with tritiated thymidine in the spleens of irradiated and non-irradiated mice was studied. The data were analyzed statistically. Results indicate that no difference exists in retained DNA specific activities in the spleen of non-irradiated mice and mice exposed to whole-body doses of 400 r γ radiation. (C.H.)

11760 HIGH EFFECTIVENESS OF CHRONIC NEUTRON EXPOSURES FOR THE INDUCTION OF SPECIFIC LOCUS MUTATIONS IN MICE. A. L. Batchelor, Rita J. S. Phillips, and A. G. Searle (Medical Research Council, Radiobiological Research Unit, Harwell, Berks, Eng.). Nature, 201: 207-8(Jan. 11, 1964).

Comparative studies in mice indicated that fast neutrons at low intensity are about 5 to 6 times as effective as x rays at high intensity for the induction of both dominant lethals in spermatozoa and specific locus mutations in spermatogonia. Implications of the findings in studies of mammalian radiation genetics are discussed. (C.H.)

11761 A PITFALL OF LOW SPECIFIC ACTIVITY RADIOACTIVE THYMIDINE. Robert B. Painter and Ronald E. Rasmussen (Ames Research Center, Moffett Field, Calif.). Nature, 201: 409-10(Jan. 25, 1964).

The action of x radiation on DNA synthesis in HeLa 53 and Chinese hamster is such that a plot of the dose-response yields a two-component curve. In order to determine if the steep component was due to pool dilution, the effect of thymidine specific activity was investigated. Tissue cultures were irradiated with x rays and incubated with the tracer isotopes. Nucleic acids were extracted and the contents estimated by absorbancy measurements at 267 mμ. Radioactivity was determined in a spectrometer. Results show that incorporation of tritiated thymidine into DNA cultures incubated with higher concentrations (lower specific activity) of thymidine was less suppressed by the irradiation than cultures incubated with high specific activity material. Further work using guanine labeled with carbon-14 failed to confirm the results. Therefore, a double labeling experiment was performed in which cells were incubated with both C^{14}-labeled guanine and tritiated thymidine. The C^{14}-guanine results paralleled the tritiated thymidine results. However in cultures where 4 mg/ml thymidine was used in conjunction with C^{14}-guanine instead of tracer thymidine, C^{14} specific activity was half. It is apparent that this effect of thymidine is such that it masks the effects of x radiation on the DNA synthesizing system by detracting from the part of rate depression contributed by the steep component of the x-ray dose-response curve. Guanine apparently does not affect DNA synthesis rate. (H.M.G.)

11762 INCREASED URINARY PSEUDOURIDINE EXCRETION IN RATS FOLLOWING IRRADIATION. D. Drahovsky (Cancer Research Inst., Bratislava), A. Winkler, and J. Skoda. Nature, 201: 411-12(Jan. 25, 1964).

Research was conducted to study the effects of radiation exposure on urinary pseudouridine excretion. White female Wistar rats weighing 150-180 g received whole-body irradiation at the rate of 18.9 r/minute. The urines of the animals were collected in 24 hour periods. Pseudouridine was isolated on Dowex 2 × 8′ in formate cycle and purified by means of paper chromatography. Pure pseudouridine in eluates was determined spectrophotometrically. Maximal urinary pseudouridine excretion in the irradiated animals was noted on the day following exposure, dropping on subsequent days by 25 percent of the values seen prior to irradiation. Increase in urinary pseudouridine was practically a linear function of radiation dose. (H.M.G.)

11763 EXPERIMENTAL STUDIES ON TRANSMITTING ABILITY OF BETA IRRADIATION WITH Sr^{90} ON THE CORNEA OF THE RABBIT. Junpei Kobayashi (Iwate Medical Coll., Morioka, Japan). Nippon Ganka Gakkai Zasshi, 65: 975-84(July 1961). (In Japanese)

The transmission of Sr^{90} β rays and visible light was compared in healthy rabbit cornea which was preserved in sterile blood at 3–6°C and physiologic saline solution. In cornea which was preserved in physiologic saline solution, transmission of β rays dropped on the 2nd hour, with the beginning of macroscopic opacity. The fall in transmission of light ran almost parallel with that of β rays; however, it showed more marked decrease from the 12th hour, compared with that of β rays. In several pieces of cornea preserved together in physiologic saline, transmission of β rays rapidly decreased from the 24th to the 36th hour, with the beginning of macroscopical opacity. Transmission of light began to decrease within 12 hr. In cornea preserved in serum, transmission rates of β rays and light waves did not show rapid decrease; the decrease was slow and at a similar rate. In several pieces of cornea preserved together in the serum, transparency was retained for the longest period. Transmission of β rays decreased relatively rapidly on the 8th day, with the beginning of macroscopical opacity. By the 2nd week, the decrease of transmission was below 50%. Transmission of light decreased gradually, at a linear rate. Transmission of β rays by the cornea was altered not only by swelling of the cornea, but by the opacity due to swelling. (BBB)

11764 A CASE REPORT OF EYE DISTURBANCES DUE TO Co^{60} IRRADIATION. H. Goto (Kobe Medical Coll., Japan). Nippon Ganka Kiyo, 13: 643-51(Dec. 1962). (In Japanese)

The patient, after an operation for maxillary cancer, was irradiated with Co^{60} to a total dose of 12,000 r. Because of development of corneal ulcer, cataract, and chronic glaucoma with pain, two years later the patient's eye was enucleated. The pathological findings are discussed. (BBB)

11765 A REVIEW OF THE BLAST PRESSURE, HEAT, AND RADIATION DOSE OF AN ATOMIC BOMB RECEIVED BY SURVIVORS WITH OPHTHALMOLOGICAL DISTURBANCES. S. Sugimoto. Nippon Ganka Kiyo, 13: 653-6 (Dec. 1962). (In Japanese)

Radiation damage to the eyes of subjects exposed to the atomic bomb in Hiroshima is surveyed. Acute radiation sickness was found even in those who were exposed to a dose of only 70–80 r. Severe burns were observed among those who had been outdoors as far as 2100 m from

the hypocenter. Cataract was found in those who received large irradiation doses (2685–3040 r) and the cataracts progress very slowly. (BBB)

11766 ACUTE EFFECTS OF GAMMA RADIATION IN MICE. [PART] I. Kenji Takeshita and Kyoichi Fujii (Kyushu Univ., Fukuoka). Nippon Igaku Hoshasen Gakkai Zasshi, 23: 40-7(1963). (In Japanese)

CF1 and ddN strain mice were exposed at a very high dose rate (8000 r/min) to Co^{60} γ radiation. The total dose to death during irradiation, obtained by following the electrocardiogram, was 111,000 ± 4000 r at this dose rate. The mean survival time (S.T.) after irradiation at various doses was obtained according to the following formula: S.T. = $660^{-0.052D}$ (in hr), for doses of more than 30,000 r, where D is in kr units. It was shown that irradiation of the head plays the main role in causing death, by inserting the head of the mouse into a lead tube (thickness 1 cm). This allowed transmission of 80% of the radiation to head. The death of the mouse resulted when the total dose to head reached to the lethal dose for whole-body irradiation. The survival time of mice during irradiation increased 60% by the injection of an LD_{50} of phenobarbital or pentobarbital compared with control mice. (BBB)

11767 INTERACTION OF RADIATION WITH MATTER. Aadne Ore (Universitetet, Blindern, Norway). Nord. Med., 67: 461-6(Apr. 12, 1962). (In Norwegian)

Primary, physico-chemical radiation reactions are discussed, with emphasis on the formation of free radicals and their subsequent attack of biological macromolecules. The nature of the biologic target is considered. (BBB)

11768 CELLULAR RADIATION EFFECTS. Finn Devik (Statens Radiologisk-Fysiske Laboratorium, Oslo). Nord. Med., 67: 533-6(Apr. 26, 1962). (In Norwegian)

Changes induced by ionizing radiations at the cellular level are discussed, especially cell death, mitotic delay, chromosome aberrations, and disruption of DNA and RNA synthesis. The possible sites of primary cellular injury are considered. (BBB)

11769 DIAGNOSIS AND TREATMENT OF RADIATION INJURY IN MAN. DIAGNOSIS. Eugene P. Cronkite (Brookhaven National Lab., Upton, N. Y.). TREATMENT. Frederick Stohlman, Jr. (St. Elizabeth's Hospital, Boston). Nucl. News, 7: No. 3, 8-15(Mar. 1964).

Types of accidents that have occurred and in which radiation injury was sufficiently severe to necessitate medical care are discussed. Radiation injuries are categorized as those from short-term exposure and those from long-term exposure. Definition of the two categories is in accordance with the United States National Academy of Sciences, National Research Council Subcommittee on Hematology. The relation of dose to radiation injury is reviewed. It is pointed out that recognition of symptoms is more important to the physician than knowledge of dosage. Accordingly, central nervous system syndrome, gastrointestinal syndrome, hematopoietic syndrome, and specific symptoms are discussed. Criteria for diagnosis of injury are clinical symptoms and their severity. Hematologic methods for determining exposure are presented. (H.M.G.)

11770 THE EFFECTS OF RADIATION. Jan Lieben (Pennsylvania Dept. of Health, Harrisburg). Nursing Outlook, 10: 336-8(May 1962).

The case is described of a nurse, the executive secretary of a tuberculosis society, who applied for workmen's compensation because of radiation dermatitis. Investigation revealed that in x raying children she was in the habit of holding them during radiographic examination—exposing her hands to the direct beam of the x-ray tube. Her hands showed typical radiation dermatitis over both dorsal surfaces. General protection procedures are outlined. It is suggested that an educational program is essential in any hospital or clinic using x rays or isotopes, and must include more than a set of rules and procedures for radiation protection. (BBB)

11771 PATHOLOGY OF THOROTRAST TUMORS IN MAN. A. Batzenschlager, M. Dorner, and M. Weill-Bousson (Institut d'Anatomie Pathologique, Faculté de Médecine, Strasbourg). Oncologia, 16: 28-63(1963). (In French)

Twenty-two cases of generalized Thorotrast deposition in men were autopsied in the Strasbourg Institut de Pathologie between 1945-1960. In five cases this deposition was associated with primary cancer of the liver or biliary ducts of the hilium: two endothelial sarcomas and three epitheliomas. This frequency of liver cancer related to Thorotrast deposition is considerably higher than that for primary liver cancer recorded for male autopsies in general, and is higher even than the incidence of liver cancer accompanying liver cirrhosis. Observations published in the literature concerning Thorotrast-induced tumors are discussed, particularly those aspects referring to topographical and chronological relations between the original deposit of ThO_2 and the subsequent appearance of the neoplasms. From these previous studies a definite carcinogenic role of Thorotrast can be cited. In the case of the present epitheliomas also, the radioactivity could directly affect the parenchymal cells as well as those of the biliary ducts, or the carcinogenic effect could be related to the sclerosis which develops and surrounds Throtrast deposits. Since primary endothelial sarcomas of the liver are a rare occurrence, in the absence of liver Thorotrast deposition, the carcinogenic action of these ThO_2 deposits can be considered proven. It is not known whether this effect is brought about directly or whether this radioactive substance is only acting as a cocancerogenic agent. (BBB)

11772 THE ULTRASTRUCTURE OF NUCLEOLI AND CHROMOSOMES DURING THE EARLY STAGES OF LIVER REGENERATION AND THE CHANGES PRODUCED IN THESE STRUCTURES BY X RADIATION. J. M. G. Davis (Cambridge Univ., Eng.). Phil. Trans. Roy. Soc. London, Ser. B, 246: 291-303(May 16, 1963).

An electron microscopic study of regenerating rat liver cells showed that, during early stages of regeneration, nucleolar size is much greater than normal, although nucleolonema fibers and pars amorpha were still present. At 16 to 18 hours after operation, however, when there is considerable production of new α-cytomembranes, much of the pars amorpha was lost, and the nucleoli consisted solely of nucleolonema fibers. Later the pars amorpha was reformed, but just before the start of mitosis at 25 to 26 hours after operation many nucleoli became very irregularly shaped. It was found that if the animal was irradiated with 450 r at either 12 or 16 hours after partial hepatectomy the nucleoli retained their compact nature in all cells and showed no structural changes at about 16 hours after operation. At this time in normal regenerating liver a diffuse type of nucleolus is found in cells that are producing new α-cytomembranes. Thus, a dose of 450 r inhibits not only α-cytomembrane production but also the concomitant nucleolar changes. When irradiation occurs 24 hours after partial hepatectomy, some of the nucleoli also show structural modifications, including a loss of

density in the nucleolonema fiber. It appears that the normal structure of the nucleoli returns when the effect of radiation wears off, and the cells resume mitosis. In a study of the effects of x radiation on mitotic chromosomes, a dose of 450 r was sufficient to inhibit mitosis completely, and no mitotic figures were found for at least 9 hours after irradiation. Some animals were irradiated at 28 hours after operation, when the highest mitotic rate is found, and killed 15 or 30 min later, making it possible to examine the immediate effects of irradiation upon the chromosomes. After a dose of 450 r no ultrastructural changes could be demonstrated in the chromosome material of any cell nuclei, but after 2000 r, ultrastructural nuclear changes were visible. These changes were most obvious in metaphase and anaphase chromosomes which often showed signs of fragmentation. The chromosome structure still appeared as an intermingled mass of fiber about 100 Å in dia, but the packing of the fibers at the edges of the chromosomes was much looser than usual, giving the chromosomes a ragged appearance. This loosening effect of 2000 r on chromosome structure was less obvious in telophase. Although the telophase chromosome ultrastructure was not noticeably changed, it was obvious that 2000 r had caused considerable mitotic derangement, and many of the telophase nuclei were very irregularly shaped. In some cases the two daughter nuclei were unable to separate completely and the nuclear membrane reformed around the whole chromosome mass. (BBB)

11773 STUDIES ON THE MECHANISM OF THE EFFECT OF FLUORODEOXYURIDINE ON CHROMOSOMES. Sandra Bell and Sheldon Wolff (Univ. of Tennessee, Knoxville and Oak Ridge National Lab., Tenn.). Proc. Natl. Acad. Sci. U. S., 51: 195-202(Feb. 1964).

It was found, in confirmation of earlier experiments, that fluorodeoxyuridine (FUdR) can induce lesions in chromosomes and that this effect of FUdR can be circumvented by exogenous thymidine. In contrast to the interpretations put forward for this effect previously, however, the present experiments show that the effect is independent of DNA synthesis in that it can occur in G_2 cells, and that the effect occurs under conditions that do not inhibit DNA synthesis. There seems to be a competitive interaction between FUdR and thymidine for sites of chromosome breakage, if, indeed, FUdR induces true breaks at all. The exact mechanism by which this or any other compound induces chromosome breaks or lesions is still unknown. (auth)

11774 THE DISAPPEARANCE OF THYMINE DIMERS FROM DNA: AN ERROR-CORRECTING MECHANISM. R. B. Setlow and W. L. Carrier (Oak Ridge National Lab., Tenn.). Proc. Natl. Acad. Sci. U. S., 51: 226-31(Feb. 1964).

The state of thymine dimers during the time in which resistant strains of Escherichia coli recover from uv-induced delays in DNA synthesis was investigated. Five strains of E. coli were labeled by growth in Mg medium containing tritiated thymidine. At various times after uv irradiation (200 ergs/mm² at 265 mμ), 1 ml aliquots of cell suspension were centrifuged, trichloracetic acid (TCA) supernatants were removed, and samples were prepared for chromatographic and counting procedures. Photoreactivating illumination was provided by black-light lamps. The radiation dose used stopped DNA synthesis and virtually eliminated colony-formation in two of the five strains. In the other three strains DNA synthesis was inhibited for 60 minutes and colony formation yields were reduced to 0.1 to 10 percent. The dimers disappeared from the acid-soluble fraction of the cells and appeared in the oligonucleotides. In a sensitive strain the dimers remained in the insoluble phase and were photoreactivable. Thus, the onset of DNA synthesis is associated with thymine dimer removal, which is suggested to be one step in cell recovery. (H.M.G.)

11775 RELEASE OF ULTRAVIOLET LIGHT-INDUCED THYMINE DIMERS FROM DNA IN E. COLI K-12. Richard P. Boyce and Paul Howard-Flanders (Yale Univ., New Haven). Proc. Natl. Acad. Sci. U. S., 51: 293-300(Feb. 1964).

The fate of thymine dimers in DNA during incubation after uv light irradiation was studied in two strains of E. coli K-12. One was a multiply auxotrophic strain, AB1157, and the other was a uv-sensitive mutant, AB1886, derived from it. Strain AB1886 is unable to reactivate uv-irradiated T1 phage and is known to have a mutation at the uvrA locus. Cells were labeled in their DNA by growth with H^3-thymidine, exposed to uv light, incubated in enriched minimal medium, and extracted with cold trichloroacetic acid. The acid precipitate and soluble fractions were hydrolyzed in hot acid, and the products were separated by paper chromatography. Thymine dimers were identified in the acid-insoluble fractions from both strains before incubation. During incubation thymine dimers were released into the acid-soluble fraction in the parental strain, AB1157, but not in the uv-sensitive strain AB1886. It is concluded that thymine dimers are excised from the DNA during the reactivation process in the uvr^+ strain and that the sensitive uvr^- strain cannot do this. These findings suggest that the enzymatic removal of injured bases, including thymine dimers, and the reconstruction of the DNA from information on the complementary strand may be an important biological mechanism for the preservation of DNA. (auth)

11776 FLUORESCENCE EMISSION OF MITOCHONDRIAL DPNH AS A FACTOR IN THE ULTRAVIOLET SENSITIVITY OF VISUAL RECEPTORS. Britton Chance (Univ. of Pennsylvania, Philadelphia). Proc. Natl. Acad. Sci. U. S., 51: 359-61(Feb. 1964).

The photodissociation of the CO compound of cytochrome a_3 at liquid nitrogen temperatures was demonstrated. Since the recombination of CO does not occur in a measurable rate at 77°K, the system provides a quantum counter for intracellular luminescence. A considerably higher uv sensitivity was found in mitochondrial suspensions and intact cells that contain DPNH than was observed in purified cytochrome oxidase (free of DPNH). Results are consistent with the viewpoint that excitation fluorescence of DPNH (maximum 340 mμ) provides a highly efficient fluorescence emission in the region of 410–500 mμ. (H.M.G.)

11777 CYTOLOGICAL ANALYSIS OF FORMALDEHYDE-INDUCED CHROMOSOMAL CHANGES IN DROSOPHILA MELANOGASTER. H. Slizynska (Univ. of Edinburgh). Proc. Roy. Soc. Edinburgh, B66: 288-304(1957).

Comparative studies on x-ray- and formaldehyde-induced genetic changes were studied by a cytological analysis carried out in female larvae of D. melanogaster whose fathers had been raised on formaldehyde-treated food. The genetic effectiveness of the treatment was measured in terms of sex-linked lethals (9%). The percent of changed spermatozoa and the mean number of breaks per spermatozoon were lower than after x-ray doses which produce 9% sex-linked lethals in mature sperm. The characteristic features of formaldehyde-induced changes, as compared with x-ray induced ones, are: a high proportion of mosaics, a shortage of inter-

chromosomal changes, a high proportion of repeats and deficiencies, and a small proportion of recovered heterochromatic breaks. The assumption that a high proportion of the original formaldehyde breaks remains at first latent, and that potential breaks in the same chromosome have a tendency to open simultaneously and often out of step with breaks in other chromosomes, gives a consistent interpretation for the mutagenic effects of formaldehyde. A detailed analysis of the data furnishes evidence for the essential correctness of this interpretation and suggests a connection between the reduplication cycle of the chromosomes and the opening of potential breaks. Initial non-random distribution of breaks and conditions of rejoining in premeiotic cells may also play a role. The evolutionary significance of the high number of repeats is pointed out. Formaldehyde food is so far the first mutagen to produce evolutionary important structural changes with high frequency. It is possible that the mutagenic action of formaldehyde food may be more closely related to the mechanism of spontaneous mutation than that of other mutagens. (BBB)

11778 EFFECT OF WHOLE-BODY X-IRRADIATION ON GLUCOSE TOLERANCE IN THE DOG. Niels O. Nielsen (Brookhaven National Lab., Upton, N. Y.). Radiation Res., 21: 180-5(Feb. 1964).

The intravenous glucose tolerance test did not reveal any change in carbohydrate metabolism in dogs receiving 650 r of whole-body x-irradiation at 24, 48, 72, and 160 hours thereafter. Dogs under prolonged pentobarbitol anesthesia showed an increase in glucose tolerance. (auth)

11779 PYRIDOXINE ABSORPTION FROM THE SMALL INTESTINE OF THE X-IRRADIATED RAT. L. E. Detrick, H. C. Upham, R. W. Springsteen, R. G. McCandless, and T. J. Haley (Univ. of California, Los Angeles). Radiation Res., 21: 186-94(Feb. 1964).

The in situ pyridoxine absorption by the intestines of rats receiving 525 r of total-body irradiation showed two deviations from the normal absorption pattern. A profound decrease in absorption was observed during the first post-irradiation week, with the greatest decrease on day three, and a secondary decrease from the tenth to the seventeenth postirradiation day. Electron microscope studies indicate mitochondrial damage from irradiation. The possible mechanisms involved in these effects were discussed. (auth)

11780 EFFECT OF TRITIATED THYMIDINE ON THE MORPHOGENESIS OF LATERAL ROOTS IN ZEA MAYS. O. L. Stein and H. Quastler (Montana State Univ., Missoula and Brookhaven National Lab., Upton, N. Y.). Radiation Res., 21: 212-22(Feb. 1964).

Primary roots of Zea mays were immersed for 5 to 24 hours in tritiated thymidine (H^3T) solutions (10 μC/ml, 50 μC/root). The roots were grown sufficiently long to permit formation of lateral roots well beyond the region of elongation at time of treatment. No effect on primary root growth during treatment was observed. Lateral roots in the region of differentiation at the time of treatment were inhibited at the early primordium level. Thus a bare region interrupts the normally conical envelope of laterals along the primary root. Lateral primordia established prior to or after the treatment appeared not to be severely affected either in number or in length. The distribution of incorporated H^3 was studied by autoradiographs of histological sections. The percentage of nuclei with label was determined separately for the cortex and the stele. In the latter, an increased number of labeled nuclei corresponds well with the inhibited region. In spite of the fact that the apical meristem is almost completely labeled, it shows much less inhibition than primordia of lateral roots in the sensitive region. Single applications of x rays inhibit lateral root formation throughout the treated region. Judiciously chosen dose fractionations can simulate the H^3T-induced bare region. (auth)

11781 THE EFFECT OF WHOLE-BODY X-IRRADIATION ON AMINO ACID TRANSPORT BY LYMPHATIC TISSUES. Isaac J. Bekhor, Praveen Shah, Dudley W. Thomas, and Lucien A. Bavetta (Univ. of Southern California, Los Angeles). Radiation Res., 21: 223-32(Feb. 1964).

The concentration of aminoisobutyric acid (AIB) in the nonprotein fraction of the rat thymus was found to be highly influenced by irradiation. It was reciprocally and linearly related to dose up to the level of 100 r, and it could be used as an index of irradiation damage in this tissue. Both glycine and AIB were lost from the cell as a result of irradiation. In the spleen the concentration of AIB was not affected by irradiation. Glycine incorporation, however, was diminished significantly at four hours after irradiation. Thus there was no relation between the concentration of AIB and the degree of protein synthesis in the irradiated cell. Results showed that tissues other than thymus and spleen responded to irradiation with an increase in their AIB concentration. Also, there was an indication of a requirement for free amino acids during the first 24 hours after irradiation, as shown by the decreased urinary excretion of AIB. (auth)

11782 SACCHARIN AVOIDANCE CONDITIONING INSTIGATED IMMEDIATELY AFTER THE EXPOSURE PERIOD. Barron B. Scarborough and William A. McLaurin (Florida State Univ., Tallahassee). Radiation Res., 21: 299-307(Feb. 1964).

Forty male Sprague-Dawley rats were used as subjects in an investigation of the extent to which x-irradiation would produce saccharin avoidance behavior in the absence of pairing of stimuli. The subjects were given four daily exposures of 10.4 r of x-irradiation, followed by 41.6 r of whole-body air exposure dose at a rate of 10.4 r/minute on the fifth day. The trace conditioning paradigm was employed with a CS period of 25 minutes, during which period groups were given a 0.1% saccharin solution, water, or nothing to drink. The CS was presented only prior to the 41.6 r exposure. All groups given the 41.6 r exposure were significantly different from each other in avoidance behavior and from the pooled sham-irradiated controls. The group given saccharin to drink and the group given nothing to drink prior to irradiation showed the greatest degree of avoidance behavior. It was concluded that the avoidance behavior of the group given no fluid to drink and the group given water to drink prior to irradiation could not be considered as a conditioned response due entirely to the effects of association of stimuli. The results are believed to be, at least in part, the direct result of the biological effects of radiation or related to the latency and duration of these effects which were associated with the discriminatory solution in the home cage. (auth)

11783 IMMEDIATE AND SHORT-TERM CHANGES IN CELL PERMEABILITY AFTER X-IRRADIATION. Vladimír Srb (Charles Univ., Prague). Radiation Res., 21: 308-13(Feb. 1964).

The effect of 1000 r of x-irradiation on immediate and short-term changes in cell permeability in the epidermal cells of Allium cepa L. were studied. On the basis of plasmolytic experiments with 1 M saccharose and with 0.56 M KNO_3 and 1 M KNO_3 at pH 5, the following conclu-

sions are valid for the experimental conditions. X-irradiation seriously damages cell permeability, which is of considerable importance for the consequent biological progress of radiation damage. The immediate changes in permeability after irradiation, simply observed plasmometrically, offer themselves as a possible initial test of this radiation damage. (auth)

11784 RADIATION-GENETIC OBSERVATIONS IN CONNECTIONS WITH A COMBINED SKULL-BRAIN DEFORMITY (TRIGONOCEPHALUS WITH A FRONTIAL CEREBRAL DYSPLASIA) IN A CHILD. D. Mueller, N. Fischer, W. Degner, F. Gietzelt, and E. W. Doerffel (Universitäts-Klinik (Charite), Berlin and Humboldt Universität, Berlin). Radiobiol. Radiother., 3: 407-20(1962). (In German)

The male offspring of a 28-yr-old nurse who had received from three to five r/month from combined radiations of ~220 mg Ra and 110 mg Ra-equivalent of mesothorium over 18 months, for an estimated total of from 50 to 90 r, and up to three months prior to parturition, was acrocephalic at birth. When seen later at age six the skull was dolichocephalic with 52.5 circumference. The root of the nose was depressed and the eyebrows were fused. The venae angulares laterales were prominent, the fossa temporales was depressed and settled stepwise against the os zygomatium. The forehead was triangularly vaulted, with palpably thickened sutures and step formation at the parietal bone transition, especially near the fontanelle, but there was no actual fontanellar eminence. The ears were malformed. The two orbits were close, with a very small os cribiforme, and with much supraorbital pneumatic space. The orbital roof and clivus were almost at the same level. The sella was deformed. The body musculature was poorly formed and generally hypotonic. Reflexes were impaired. Motor speech function and phonation were disturbed. The ECG showed marked dysrhythmia and some paroxysmal focal character, and suggested some impairment in the left hemisphere. The pneumoencephalogram indicated that the entire ventricular system, including the subarachnoidal space, was symmetrical without longitudinal compression or elongation. The anterior horns and third ventricle, as well as the basal cistern, including the base of the cisterna pontis, were widened. The cisterna chiasmatis was not filled. (BBB)

11785 BIOCHEMICAL CONTROL OF THE COURSE OF IRRADIATED PATIENTS. K. H. Kaercher and J. Becker (Universität, Heidelberg). Radiologe, 2: 304-9(Aug. 8, 1962). (In German)

The activity of lactic dehydrogenase (LDH, a glycolytic cycle enzyme) and malate dehydrogenase (MDH, a citric acid cycle enzyme) was determined in serum of patients undergoing radiation treatment. It is suggested that changes in the activity of these enzymes measured in the first three days reflect the radiosensitivity of the tumor, whereas results obtained at later periods may give an indication of recurrence of the tumor process. Enzyme determinations after conclusion of therapy may also show metastasis. In cases of bronchial carcinoma, for example, the enzyme values were pathologically high before irradiation. Six hours after an initial radiation dose of 200 r, the enzyme values continued to increase by more than a third. As the patient's general condition improved, the enzyme values dropped to normal. Three months later the enzyme values had returned to the pathological range, although the patient was clinically healthy. Later, lung metastases appeared accompanied by severe pains. The examination of these changes in LDH and MDH activities at various phases of the treatment make the prediction of the outcome of the treatment possible. In the case of a gastric carcinoma the enzyme values were normal before the start of the radiation therapy, and 6 hours after the first dose of 400 r Co^{60} γ radiation only a slight change in the enzyme activity could be detected. Later, during the course of irradiation the enzyme activities reached pathological values. At this point the patient's general condition declined markedly, and progressive recurrence of the tumor could be demonstrated. The enzyme pattern during irradiation clearly showed the low radiation sensitivity of this tumor, allowing prediction of an unsuccessful outcome of the treatment. Enzyme determinations may also be useful in differential diagnosis. (BBB)

11786 ON THE PROBLEM OF THE SPECIFIC BIOLOGICAL EFFECTIVENESS OF SOFT RADIATION AS A FUNCTION OF THE INHOMOGENEITY OF DOSE DISTRIBUTION IN TISSUE. W. Gahlen (Staedtische Hautklinik, Aachen). Radiologe, 2: 389-91(Oct. 10, 1962). (In German)

The relation between the dose and the biological reaction, the relative biological effectiveness (RBE), is proportional to the tissue homogeneity. For soft x radiation the greater the spatial inhomogeneity, the greater the RBE is increased. Differential analysis of the depth dose curves for soft radiations in tissues permits some conclusions to be drawn about the degree of homogeneity of the radiation that passes through, but not to what extent the particular degree of homogeneity exerts a biological reaction. The degree of homogeneity does not indicate any unit of absorption or any amount of energy absorbed from any source, which as such necessarily must alter biological reactions. This is especially true for instances of marked inhomogeneity. Prior absorption will determine the particular depth dose. In skin tissue it is probably not significant that soft radiation with a pronounced energy transfer produces a greater biological effect in microvolumes than an exposure to the same dose of hard x radiation produces. There is no experimental indication that the biological effectivity of soft radiations is not proportional to the dose distribution in tissue. (BBB)

11787 EXAMINATION OF CHANGES IN SOME HUMORAL INDICES OF RHEUMATIC ACTIVITY (WITH SPECIAL REFERENCE TO HAPTOGLOBIN) DURING TREATMENT WITH RADIOACTIVE MUD AND MINERAL WATER. M. Giordano, G. Tirri, and E. Drammis. Reumatismo, 15: 8-16(Jan.-Feb. 1963). (In Italian)

Variations in blood factors in arthritic patients undergoing balneotherapy with naturally radioactive materials were followed, but the direct effect of radiation on these changes could not be assessed. (BBB)

11788 LESIONS PRODUCED BY NUCLEAR RADIATIONS DURING AN ATOMIC EXPLOSION IN AN URBAN CENTER. [PART] 9. Jesus M. Farias Rodriguez. Rev. Sanidad Mil. (Mex.), 17: 166-73(Mar.-Apr. 1963). (In Spanish)

The most frequent and important lesions produced by the atom bombs detonated over Hiroshima and Nagasaki, and which developed within 15 weeks following the explosion, were analyzed. Mortality and the severity of these lesions caused mainly by γ rays and neutrons were correlated with survival, symptomatology, and distance from the explosion. Reference was made to the vulnerability of immature cells to radiation. Damage to various systems in the body were discussed in detail, as also the general symptoms of persons exposed to a lethal dose. Mention was made of lethal complications developing in groups of

possible survivors, and recomendations were given for lessening or avoiding bodily damage during a nuclear attack. Finally, treatment for radiation damage was discussed. (BBB)

11789 EXPERIMENTAL VENTRICULAR TACHYCARDIA DURING RADIATION SICKNESS. Lubor Vokrouhlicky, Vilo Jurkovic, Zdenek Belobradek, and Vojtech Grossmann (Charles Univ., Königgrätz, Czechoslovakia). Sb. Ved. Praci Lekar. Fak. Karlovy Univ. Hradci Kralove, 6: 27-30(1963).

In rabbits under urethane narcosis, ventricular tachycardia was induced by injecting 0.05 ml of a 0.05% aconitine solution in the heart apex, and the animals were irradiated with a dose of 1000 r. By electrocardiogram (ECG) the course of tachycardia was observed with administration of 1% procaine solution therapeutically or preventively in various forms (in muscle, in the region of the cervical vagosympathetic nerve, and in slow intravenous infusion). All observations were made on the 3rd or 6th day after irradiation. In nonirradiated animals, the urethane narcosis, tracheotomy, thoracotomy, injection of physiological saline into the heart, or infusion of procaine showed no marked effect on the ECG. In irradiated animals, frequent minor rhythm disorders appeared during simple experimental procedures. After procaine (on the 6th day after irradiation), frequent occurrence of supraventricular and ventricular arrhythmias and a change in the configuration of QRS were observed. The changes were frequent, especially after the vagosympathetic block with procaine. In nonirradiated animals procaine normalizes 30% of tachycardias when applied subcutaneously after inducing tachycardia, in 33% with infiltration of vagosympathicus, and 16% with intravenous infusion. In preventive application, intravenous infusion is the most effective (75% normalizations). On the 3rd day after irradiation, procaine also has a favorable effect, though diminished in comparison with the nonirradiated animals: in therapeutic administration 33% of tachycardias are normalized with infiltration of vagosympathicus and 16% with intravenous infusion. In preventive intravenous use its efficacy has diminished to 58% normalizations. On the 6th day after irradiation the preventive and therapeutic efficacy of procaine is greatly diminished. If procaine was applied therapeutically after inducing tachycardia, infiltration of vagosympathicus gave only 11% normalization, intravenous infusion 25%. Thus after whole-body irradiation with 1000 r in the rabbit there is a tendency to arrhythmias and disorders in conductivity. The change of the definitely antifibrillatory effect of procaine into a profibrillatory one on the 6th day after 1000 r is surprising, and has not been reported in the literature previously. (BBB)

11790 CHANGES OF THE MINERAL METABOLISM IN RADIATION DISEASE. Josef Vycichl (Charles Univ., Koniggratz, Czechoslovakia). Sb. Ved. Praci Lekar. Fak. Karlovy Univ. Hradci Kralove, 6: 39-40(1963). (In Czech)

Rats were irradiated by a single whole-body dose of 500 r, and changes of the levels and concentrations of sodium, potassium, and chloride in serum, heart and skeletal muscle and in the renal cortex were studied. The investigations were performed at intervals of 12 and 24 hr, 3, 6, 10, and 15 days following irradiation. In the serum the Na level was decreased on the 3rd day and increased on the 10th day after irradiation. In heart muscle a decrease of K concentration on the 3rd day and an increase of Na concentration on the 10th day were found. In the cortex of the kidney a decrease of Na concentration in 24 hr and on the 6th day, and an increase on the 15th day took place. At 24 hr a decrease of K concentration, and an increase of Cl concentration on the 10th day, were observed. In skeletal muscle a decrease of Na concentration at 24 hr and an increase on the 15th day were found. The K concentration was decreased in 12 hr and on the 15th day. The concentration of Cl was increased on the 10th day. All these changes were statistically significant. In rabbits after whole-body irradiation with a dose of 1000 r the serum levels of K and the concentration of K in heart muscle on the 3rd and 6th days following irradiation were unchanged. (BBB)

11791 INFLUENCE OF OCCUPATIONAL EXPOSURE TO IONIZING RADIATION ON BLOOD PRESSURE AND THE PULSE. Dusan Kolesar (Charles Univ., Bratislava). Sb. Ved. Praci Lekar. Fak. Karlovy Univ. Hradci Kralove, 6: 31-3(1963). (In Russian)

The results are summarized of a 2-year survey of the influence of ionizing radiation on the blood pressure and pulse in 64 men and 56 women, who were treated clinically in the Clinic of Occupational Diseases in Bratislava. The patients were examined first before entering the occupation then during the course of the following two years work. It was found that the changes of pulse show a tendency toward acceleration, but statistically insignificant. However, the frequency of changes in the blood pressure with regard to the average dispersion from the point of the initial value of the blood pressure was statistically significant already at the end of the first year's exposure even though the actual changes in blood pressure weren't significant even at the end of the second year's exposure. (BBB)

11792 CHANGES IN VASCULAR REGENERATION IN THE WOUNDS OF IRRADIATED ANIMALS. Jirii Smahel and Zdenek Charvat (Charles Univ., Koniggratz, Czech.). Sb. Ved. Praci Lekar. Fak. Karlovy Univ. Hradci Kralove, 6: 41-2(1963). (In Czech)

As is well known the reparative processes in skin wounds are markedly altered after irradiation; attempts were made to evaluate these changes. In a study of the reparative processes in skin wounds in rats, the observation was made that regeneration of blood vessels in the wounds of nonirradiated animals proceeds in three qualitively different and well-distinguishable stages which can be used for statistical evaluation. In rats which were whole-body irradiated with 600 r before the injury the regenerative vascular processes show these three stages which, however, are significantly prolonged as compared with the controls and show certain morphologic differences as well. (BBB)

11793 COSMIC RADIATION AND TUBERCULOSIS. IV. INFLUENCE OF COSMIC RADIATION ON TUBERCULOSIS AT HIGH ALTITUDE (3,130 m) AND AT SEA-LEVEL. S. G. Ong (Inst. of Epidemiology and Microbiology, Academy of Medical Sciences, Peking). Sci. Scinica (Peking), 13: 61-80(Jan. 1964).

At high altitude (3,130 m) tuberculous mice exposed to cosmic radiation under 10 cm of lead showed significantly greater mean survival time and a significantly greater number of survivors than tuberculous mice exposed to direct cosmic radiation. Tuberculous mice exposed to cosmic radiation at high altitude under 10 cm of lead showed a significantly greater mean survival time than tuberculous mice kept at sea level, exposed to direct cosmic radiation, and to cosmic radiation under 1, 2, and 10 cm of lead. The correlation analysis shows that a decrease in lung lesions is associated with an increase in survival time. The decrease in lung lesions is associated with an enlargement of the spleen. At high altitude the female showed a signifi-

cantly greater number of survivors than the male. At sea level no significant difference was observed. On the average the female showed a significantly greater number of survivors. The beneficial effect of daylight with ultraviolet light on tuberculous mice was manifested in a lower maximum of mortality and in a significant decrease of lung and spleen lesions. (auth)

11794 ALLELIC MAPPING IN YEAST BY X-RAY-INDUCED MITOTIC REVERSION. T. R. Manney and R. K. Mortimer (Univ. of California, Berkeley). Science, 143: 581-3(Feb. 7, 1964).

A new method for determining the sequence of mutational sites is based on the linear dose-effect relation for x-ray induction of allelic recombination in Saccharomyces cerevisiae. Mutations at two loci were mapped by this method. The use of x ray simplifies allelic mapping and greatly increases its sensitivity. (auth)

11795 RADIATION-INDUCED MOUSE LEUKEMIA: CONSISTENT OCCURRENCE OF AN EXTRA AND A MARKER CHROMOSOME. Niel Wald (Univ. of Pittsburgh), Arthur C. Upton, Vernon K. Jenkins, and Wayne H. Borges. Science, 143: 810-13(Feb. 21, 1964).

Granulocytic leukemia, induced in the primary mouse by x-irradiation, was serially transmitted to RF/Up mice. An extra chromosome, as well as a morphologically unusual chromosome, was found in the bone marrow cells of all the leukemic mice that had been injected previously either with leukemic spleen cells or with cell-free ultracentrifugates. This suggests that the changes in the chromosomes are caused by a virus. (auth)

11796 NUCLEIC ACID AND RADIATION. Masami Kiga (Showa Medical School, Japan). Showa Igakukai Zasshi, 22: 331-7(Nov. 1962). (In Japanese)

The effects of ionizing radiations on DNA and RNA and their constituents are reviewed. (BBB)

11797 THE EFFECTS OF INITIAL NUCLEAR RADIATION ON THE STRIKING POWER OF TROOPS. Arne Nelson (Research Inst. for National Defense, Sundbyberg, Sweden). Tidskr. Mil. Halsovard, 86: 23-41(1961). (In Swedish)

Injury from radiation and other effects of thermonuclear weapons is discussed. It is pointed out that the development of low-yield tactical nuclear devices increases the importance of initial radiation effects as compared with those of blast and thermal radiation. In view of this, the time course of radiation disease and its severity at different dosage levels are considered. Data obtained from Japanese survivors, nuclear accidents, and complications of radiotherapy are evaluated and interpreted in terms of military problems. (BBB)

11798 IMPORTANCE OF CELL INJURY IN THE RADIATION REACTION OF THE ANIMAL ORGANISM. E. Ya. Graevskii, I. M. Shapiro, M. M. Konstantinova, and N. F. Barakina (Severtsov Inst. of Animal Morphology, Moscow). p.177-91 of "Pervichnye i Nachal'nye Protsessy Biologicheskogo Deistviya Radiatsii." Moscow, Publishing House of the Academy of Sciences, 1963.

Processes of tissue regeneration after irradiation and means for protection against radiation are reviewed (75 references). The reaction of mammals to radiation is due primarily to cell changes and the death of a large number of the cells in the hematopoietic organs and intestinal mucosa. Late cell destruction that follows massive destruction results from chromosome imbalance or inability of the cells to complete division because of interference with structural changes in the chromosomes. The basic factor limiting tissue regeneration after 700- to 3000-r doses is the small number of viable cells since most of these have lethal chromosome rearrangements; with a minimum absolute lethal dose (700 r for mice) this may amount to 70 to 90%. Delay in development of damage may in some cases decrease it. Unexplained differences in radiation sensitivity of the hematopoietic system and the intestinal mucosa may be due to differences in the numbers of cells damaged in the early massive destruction and the lethal chromosome damage, in the rate of cell multiplication, and in the minimum number of cells needed to maintain viability of the irradiated animal. Protective agents weaken the effect of radiation by increasing the number of viable cells and the rate of restoration of the ability to divide. Protective substances decrease the oxygen tension in the tissues; the protective action of transfer agents is related to the creation of a hypoxia in the cells whether these accumulate in the cells or lower the oxygen tension otherwise. (TTT)

11799 IMMUNITY AND HOST RESPONSE IN THE GROWTH OF TRANSPLANTED TUMORS. J. V. Sparck. A Monograph. Copenhagen, Munksgaard, 1962. 122p.

Experiments are reported on transplantation of mammary tumors to mice which had been subjected to x rays and various other kinds of modification. Tumor growth following implantation of spontaneous mammary-carcinomas isologous to the recipient C3H mice was significantly inhibited when whole-body x irradiation was applied to the recipients. Inhibited growth of tumor isografts was found to be characteristic in radiation chimeras in general and not to be influenced by the type of cells (isologous or homologous) used for protection after lethal irradiation. C3H mice which had survived sublethal whole-body irradiation exhibited a corresponding repression of the growth of isologous tumor implants. This effect persisted for months after irradiation, and growth inhibition of the isologous tumor was obtained whether irradiation took place before or after the implant was established. It was confirmed that with homologous DBA tumor grafts to C3H recipients the effect of irradiation was a delayed rejection response; there was no increase in the tumor size. Administration of cortisone to the C3H-recipients of grafts of primary isologous mammary-carcinomas had a strong inhibiting effect on progressive growth of the tumors. In the transplantation of corresponding, but incompatible homologous DBA carcinomas to C3H mice the effect of cortisone expressed itself in a different way. Thus it tended to inhibit the initial tumor growth but the subsequent regression of the tumors was delayed. Primary spontaneous C3H mammary-carcinomas implanted in homologous radiation chimeras (C3H/AKA) were shown to exhibit changed transplantability characteristics. It is suggested that the change is induced immediately upon transfer to the chimera and, accordingly, a single passage of the homotransplantable subline in the strain of origin (C3H) caused an immediate reversal to the original strain specificity. Serologic analysis of cell preparations of tumors developed in C3H/DBA radiation chimeras following implantation of C3H carcinomas demonstrated the presence on large numbers of cells of antigens sp. for the homologous component in the host. From these results on treatment of recipient mice with whole-body x irradiation or cortisone it is concluded that progressive tumor development in the system studied depends on the response of the host. Both treatments are known to inhibit the capacity of the organism to carry out various reactions, including inflammation, tissue repair processes, and immune reactions. The importance of the host's immunologic responses to the

implanted tumor, which are repressed by agents, is discussed. (BBB)

11800 THE EFFECT OF X-IRRADIATION ON MITOSIS AND DNA SYNTHESIS IN EHRLICH ASCITES TUMOR CELLS. Jae Ho Kim. Thesis, Iowa City, Iowa, Iowa State Univ., 1963. 119p.

Effects of x irradiation (300 r, 500 r, and 1,000 r) on mitosis and DNA synthesis of Ehrlich ascites tumor cells were studied. Dose-effect relations and time sequence on effects on the 2 processes were compared. The normal mitotic cycle of Ehrlich ascites tumor cells was determined by the method of tritiated thymidine labeling. The period of mitosis, M, was found to be 1 hr. This was followed by a period, G_1, of about 6 hr. The next period synthesis, S, lasted about 8 hr. The final stage, G_2, was 4 hr in duration. Various doses of x irradiation to tumor cells in vivo produced an immediate block in the G_2 period, resulting in the mitotic index dropping within an hour to a minimal value. The duration of mitotic inhibition was dependent upon radiation dose. There was a temporary increase in mitotic index above normal after release of the mitotic inhibition. The rate of DNA synthesis after various doses was reduced, as indicated by an increase in percentage of cells labeled in irradiated cells and by a decrease in mean grain count. The effect of irradiation on DNA synthesis was not as apparent as that on the mitotic index. There was no appreciable reduction in the rate of entry of irradiated cells from G_1 into S periods as studied by continuous in vivo labeling of DNA with H^3-thymidine. It was concluded that x irradiation affected processes in 2 stages of the cell cycle, G_2 and DNA synthesis. (M.P.G.)

11801 EFFECTS OF RADIATION AND SUPRAGRAVITATIONAL FORCES ON GROWTH. Betty Fountain Edwards. Thesis, Atlanta, Emory Univ., 1963. 219p.

The combined effects on growth of supranormal gravity and x radiation were studied. Germinating wheat seedlings and 10-day chick-embryo muscle tissue were used. Both were subjected to varying doses of x radiation, followed in some cases by continuous centrifugation to produce a force of 150 times normal gravity. Wheat seedlings were remarkably resistant to radiation. They were slightly stimulated by a 600-r dose and relatively unaffected by doses below 2400 r. Wheat coleoptile growth was depressed to ~50% by radiation doses of ~40,000 r and also by the continuous gravitational force of 150 g. Root length was more readily affected, being reduced to 50% by 10,000 r of x radiation and to 25% by the force of 150 g. Above 40,000 r there was little further change in growth response of either coleoptile or root. When irradiated plants were centrifuged, the growth depression resulting from radiation did not begin until larger doses were administered than those which affect non-centrifuged plants. The total inhibition of growth obtained was much less than the sum of the depression effects produced by each factor acting alone. The influence of hydration of seeds on their radiosensitivity was studied. Generally, seeds irradiated dry were less affected than seeds irradiated after soaking for more than 3 hours. A reversal phenomenon at higher radiation doses was not altered in centrifuged plants. Chick-embryo muscle cultures responded to both radiation and centrifugation by a decrease in the number of fibroblasts which grow out from the initial explant. The growing striated muscle was not grossly affected by either factor at the levels employed in these experiments. Cultures centrifuged at 150 g following irradiation at 200, 400, and 800 r showed little evidence of additional inhibition of fibroblast outgrowth, even at 800 r, although giant cells and nuclear abnormalities were increased. This study indicates that growth of both wheat seedlings and chick-muscle cultures are less radiosensitive under the influence of higher-than-normal gravitational force than at normal gravity. (M.P.G.)

11802 EFFECTS OF GAMMA-RAY IRRADIATION ON POLLEN. Pao-min Tseng. Thesis. Madison, Wis., Univ. of Wisconsin, 1963. 70p.

The effect of γ-irradiation on pollen germination, division of the generative nucleus, mitotic divisions within the embryo and endosperm, and fruit and seed sets was studied. Pollen of Solanum tuberosum var. AG 231 and diploid peony was irradiated at 1, 10, 20, and 40 kr, and that of Lilium regale and L. hybridum at 1, 2, 4, and 10 kr. The irradiated pollen was germinated on a liquid medium containing sucrose and boric acid. The results of germination indicated that pollen radiosensitivity is correlated to pollen size and chromosome number and size. L. regale and L. hybridum pollen was used for examination of the mitotic division of the generative nucleus in the pollen tube in vitro. All of the mitotic configurations were abnormal following irradiation at 10 kr. Chromatid break, isochromatid break, and fragment were the main aberrations. On the basis of chromosome number, the % of aberrant chromosome increased as doses increased. The number of fragments per nucleus had no direct correlation with dosages. Chromatid breaks tended to increase with doses. The number of isochromatid breaks per 100 nuclei was much higher than that of chromatid breaks. The mitotic aberrations in the embryo and endosperm of potato following pollen irradiation included precocious or late movement of chromosomes at metaphase, bridges and fragments at anaphase, and increased ploidy. AG 231, L. regale, and L. henryi were used for fruit and seed sets following irradiation. Fruit size and seed sets declined with increased dosages. That required for impairment of seed set was usually lower than that required for fruit failure. The % of seed sets per fruit is in accordance with the % of normal mitoses leading to the formation of the male gametes. (M.P.G.)

11803 PERVICHNYE I NACHAL'NYE PROTSESSY BIOLOGICHESKOGO DEISTVIYA RADIATSII. (Primary and Initial Processes of Biological Effects of Radiation). G. M. Frank, N. A. Aladzhalov, and N. N. Demin. Moscow, Publishing House of the Academy of Sciences, 1963. 278p.

Twenty-five papers and a panel discussion presented at the Symposium on Primary and Initial Processes of the Biological Effects of Radiation are given. Separate abstracts were prepared for 6 papers. Five papers were previously abstracted for NSA. (M.C.G.)

For abstracts of individual papers see: 11798, 11804, 11805, 11806, 11807, and 11899.

11804 EFFECTS OF RADIATION ON PROTEIN AND NUCLEIC ACIDS IN SOLUTION AND AT INTERFACES. A. G. Pasynskii (Biochemistry Inst., Moscow). p.35-44 of "Pervichnye i Nachal'nye Protsessy Biologicheskogo Deistviya Radiatsii." Moscow, Publishing House of the Academy of Sciences, 1963.

The effect on proteins of sublethal radiation doses, e.g. 400 to 500 r, may be studied by irradiation of protein solutions containing methionine-S^{35} and following the activity. Ordinary physico-chemical methods show the effects of radiation only of the order of 10^5 r. Nucleic acid changes may be observed by the usual methods, which are sensitive to changes caused by 50 r. A basic chemical

change in the irradiated protein molecule is oxidation of the SH group. Molecular aggregation increases, solubility decreases, the activity of the functional protein group increases, and the methionine-S^{35} and other bonding is strengthened. These effects may be explained by formation of organic radicals. The basic question posed is: Why does damage to a few cells cause serious results while damage to many may have a less serious effect? Results of work are discussed, and it was concluded that the effect of some damaged molecules in the cell may be due not to any peculiarity of the structure but to their action at the molecular interfaces. Damage may thus change the transfer constant even though the bulk of the enzyme molecules is unchanged. (TTT)

11805 EFFECT OF X RAYS ON INTRACELLULAR FORMATION OF BACTERIOPHAGE. F. Gerchik (Biophysics Inst., Brno). p.53-6 of "Pervichnye i Nachal'nye Protsessy Biologicheskogo Deistviya Radiatsii." Moscow, Publishing House of the Academy of Sciences, 1963.

Escherichia coli bacteria were grown on nutrient agar and irradiated with x rays (60 kv, 4 ma, 4 kr/min) to doses of 4 to 960 kr. After 120 kr, only one cell in 10^6 was able to form colonies. Immediately after the irradiation, phage production decreased only approximately linearly with increasing dose on a semilogarithmic scale. However, after 24 hr, the production decrease was linear on this scale, very rapid with 4- to 8-kr doses but very slow with higher doses. Above 80 kr, phage production became more radiation-resistant. The addition of chloramphenicol significantly decreased phage production. When it was added during the stationary phase, the decrease was only 10-fold, but when added during the logarithmic phase, the decrease was 222-fold. Two possible explanations are offered: either the phage is released from a few surviving cells, or it is released very slowly from many cells. The effects may be related to suppression of protein synthesis by chloramphenicol with simultaneous interference with polymerization of nucleic acids and accumulation of DNA precursors. The experiments are not completed. (TTT)

11806 RADIATION DAMAGE OF LIPIDS IN THE CELL MICROSTRUCTURE. N. N. Demin and B. D. Blokhina (Academy of Medical Sciences, Moscow). p.110-7 of "Pervichnye i Nachal'nye Protsessy Biologicheskogo Deistviya Radiatsii." Moscow, Publishing House of the Academy of Sciences, 1963.

From Co^{60}-gamma-irradiated and control rabbits, the lipids of the liver and intestinal mucosa were separated by chemical methods into free, weakly bonded, and stably bonded fractions. Forty percent of the liver cytoplasm dry weight were lipids, practically all combined, primarily weakly combined. Thirty percent of the hyaloplasm was lipid, 40% of this was in the free state and the combined was mostly in the stably bonded condition. At 24 hr after irradiation, the totals were higher, with more of the stably combined in the hyaloplasm and more of the weakly combined in the cytoplasm. At 72 hr the totals had dropped in both, with the combined being significantly lower in the hyaloplasm and much below normal in the cytoplasm. In similar studies on the intestinal mucosa, the lipid fractions were determined in the mitochondria, microsomes, and hyaloplasm. The relative amounts of stably bonded lipid at 2 and 24 hr were lower in the microsomes but higher in the mitochondria; this was reversed at 72 hr. Weakly combined lipid dropped significantly in the microsomes, and in the mitochondria it rose and then dropped. The free lipid changed little in the mitochondria but increased significantly in the microsomes. In the hyaloplasm the total increased, especially the stably bonded. (TTT)

11807 RADIATION DAMAGE TO THE RHYTHM OF OXIDATION PROCESSES. G. M. Frank and A. D. Snezhko (Biophysics Inst., Moscow). p.202-15 of "Pervichnye i Nachal'nye Protsessy Biologicheskogo Deistviya Radiatsii." Moscow, Publishing House of the Academy of Sciences, 1963.

The free oxygen tension in tissues was measured by the current produced when an open platinum needle electrode was placed in the tissues. As a supplementary method, the so-called "oxygen test" was used, in which an exact amount of oxygen is inhaled by the animal (or supplied to the tissue). The increase in inhaled oxygen causes an increase in the electric current, which returns to normal 1.5 to 2 min after the oxygen supply is stopped. The ability of the tissues to use the added oxygen is impaired by irradiation. Curves are shown for the change in current in the brain of rabbits in the presence of oxygen after whole-body roentgen irradiation and in parts of the brain after selective irradiation. In normal tissue the oxygen level is not constant, but occurs in waves; irradiation disrupts the rhythm. Curves are also given for the change in rhythm in the brain of rabbits and in bean rootlets with irradiation. The results are discussed, and the rhythm study is judged to be a step in the experimental analysis of mechanisms of regulatory processes. (TTT)

11808 STRAHLENPATHOLOGIE DER ZELLE. BEITRÄGE ZUR ZYTO- UND HISTOPATHOLOGIE DER STRAHLENWIRKUNG. (Radiopathology of Cells. Contribution to the Cyto- and Histopathology of Radiation Effects). Eberhard Scherer and Hans-Stephan Stender. Stuttgart, Georg Thieme Verlag, 1963. 400p. DM 90.

A series of articles on the radiopathology of cells of warm-blooded animals is presented. The topics discussed are radiation effects on the individual cell formations, radiation effects on the cells of important organs, radiation effects on tumor cells, and manifestations of cellular damages. Separate abstracts have been prepared of the individual articles. (J.S.R.)

For abstracts of individual papers see: 11809, 11810, 11811, 11812, 11813, 11814, 11815, 11816, 11817, 11818, 11819, 11820, 11821, 11822, 11823, 11824, 11825, 11826, and 11827.

11809 RADIATION EFFECTS ON INDIVIDUAL CELL FORMATIONS. CELL NUCLEI. E. Fasske and H. Themann. p.1-31 of "Strahlenpathologie der Zelle. Beiträge zur Zyto- und Histopathologie der Strahlenwirkung." Stuttgart, Georg Thieme Verlag, 1963.

The morphological visible substrate of cell damage caused by radiations shows no variation whether the injury is the result of direct effects or initial cytoplasmic damage. The modifications induced by x or Co^{60} radiations (nuclear swelling, giant cell formation, nuclear vacuoli, nuclear pycnosis, nuclear membrane wrinkling, karyolysis, and karyorhexis) were extensively studied by electron microscopy. The initial radiation damage affects the nuclear membrane, whose external lamella was skimmed off and thus expanded the intermembrane space. Many of the juxtanuclear vacuoli, microscopically visible after irradiation, have both nuclear membranes driven apart. Although in nucleoplasm there is no essential alteration except for an occasional "dilution", the chromosomal substance frequently gives way at the internal lamella of the nuclear membrane under coagulation and contrast in-

crease. Also a chromatin oscillation can occur. The supposition that the radiation insult directly hits the DNA molecule in the chromatin can be experimentally checked for very high doses. Electron microscope investigations of isolated DNA shows that the DNA filament is decomposed into several fragments under x irradiation of more than 100 kv. Spiral coiling and cross linking also are signs of molecular damage. Ionizing radiation adversely affects the synthesis of the DNA molecule. The introduction of tritium-labeled thymidin into the DNA can be used to follow the synthesis. Radioautography permits a distinction to be made between radiosensitive nuclei (testicle epithelium) and less sensitive nuclei (liver epithelium). Radiation damage was also produced by the introduction of high P^{32} doses into the nuclei. The most sensitive to such incorporation damages are bone marrow, spleen, thymus, and lymph nodes. 91 references. (tr-auth)

11810 RADIATION EFFECTS IN INDIVIDUAL CELL FORMATIONS. NUCLEOLUS. K. Peters. p.32-46 of "Strahlenpathologie der Zelle. Beiträge zur Zyto- und Histopathologie der Strahlenwirkung." Stuttgart, Georg Thieme Verlag, 1963.

The results of studies of radiation effects on nucleoli show a relatively high radiation sensitivity for these cell orgnellae. Under some experimental conditions the sensitivity of the nucleolus exceeds that of cell nuclei. The nucleolus plays a significant role in the RNA synthesis of the cell and represents a site of active metabolism. On the basis of the interaction of RNA metabolism and protein synthesis, the nucleolus is of prime importance for the cell. Its contribution to the synthesis of mitotic spindle protein and to the detection of numerous enzymes and specific proteins makes the nucleolus of great interest in radiobiological reactions. In the interpretation of the results of radiation research, it is necessary to distinguish between the irradiation of the cells in the cell union (in vivo or vitro) and the reactions following direct irradiation with microbeams (uv light or x-ray beams). After irradiation in the cell union, size increase of the nucleoli, wide-spread RNA synthesis, or no effect on the nucleolar RNA was established. Microirradiation of the nucleolus, on the other hand, leads to fragmentation, stopping of mitosis, and inhibition of RNA and protein synthesis. 109 references. (tr-auth)

11811 RADIATION EFFECTS ON INDIVIDUAL CELL FORMATIONS. CYTOPLASM AND MITOCHONDRIA. E. Scherer. p.47-68 of "Strahlenpathologie der Zelle. Beiträge zur Zyto- und Histopathologie der Strahlenwirkung." Stuttgart, Georg Thieme Verlag, 1963.

The radioinduced damage to nucleus and plasma, as reported in the literature, is briefly reviewed. The morphology and function of mitochondria are given in a general fashion, and the metabolic functions are discussed in some detail. The properties of the ergastoplasm are summarized. The radiobiological studies made on cytoplasm and its constituents are considered in conclusion with individual treatment of studies on cell ferments, tissue homogenates, and isolated mitochondria. 113 references. (J.S.R.)

11812 RADIATION EFFECTS ON INDIVIDUAL CELL FORMATIONS. MEMBRANES. H. D. Bergeder. p.69-84 of "Strahlenpathologie der Zelle. Beiträge zur Zyto- und Histopathologie der Strahlenwirkung." Stuttgart, Georg Thieme Verlag, 1963.

The effect of ionizing radiation on membranes is discussed by a description of the morphological changes in the membranes, the alteration of the concentration gradients, variation in the electrical properties of cells and tissues, and modification of sensitivity and excitatory process. The problem of radioinduced membrane damages is considered in conclusion. 102 references. (J.S.R.)

11813 RADIATION EFFECTS ON INDIVIDUAL CELL FORMATIONS. INVESTIGATIONS ON TISSUE CULTURE. H. Gaertner. p.85-128 of "Strahlenpathologie der Zelle. Beiträge zur Zyto- und Histopathologie der Strahlenwirkung." Stuttgart, Georg Thieme Verlag, 1963.

As most radioinduced pathophysiological effects occur on the cellular level, cell and tissue cultures are being increasingly used for radiocytological research. The definitions and methods of tissue cultures are examined. The effect of the growth medium on the radiation reaction in the tissue cultures is indicated. Cytological studies on irradiated cultures are discussed with a consideration of mitosis inhibition, mitosis damage, perturbation of the cell movements, radiosensitivity of cell nuclei and cytoplasm, and radio-induction of giant cells. Radioinduced cellular death, both instantaneous and delayed, is described. The metabolic chemical studies on irradiated tissue cultures include inhibition of mitosis and DNA synthesis, study of the origin of this inhibition, RNA and protein synthesis, and radiosensitization and protection. The effect of the radiation quality on the radiobiological reaction is discussed, and the reaction in vivo and in vitro is compared. 330 references. (J.S.R.)

11814 RADIATION EFFECT ON CELLS OF IMPORTANT ORGANS. BLOOD-BUILDING TISSUE. H. Hartweg. p.129-48 of "Strahlenpathologie der Zelle. Beiträge zur Zyto- und Histopathologie der Strahlenwirkung." Stuttgart, Georg Thieme Verlag, 1963.

The acute radiation reaction of bone marrow is described in some detail with a discussion of the destruction phase, histology, cytology, primary cell damage, secondary cell damage, and the regeneration phase. Radiation effects on erythrocytes, granulocytes, and thrombocytes are summarized. 92 references. (J.S.R.)

11815 RADIATION EFFECTS ON CELLS OF IMPORTANT ORGANS. SPLEEN AND LYMPH NODES. H. St. Stender. p.149-80 of "Strahlenpathologie der Zelle. Beiträge zur Zyto- und Histopathologie der Strahlenwirkung." Stuttgart, Georg Thieme Verlag, 1963.

Radiation damage to the spleen and lymph nodes passes through the phases of destruction, phagocytosis, relative inactivity, and regeneration. The lymphocytes fail in the interphases within several hours. The number of pycnosis is dose dependent. The morphological and biochemical effects of small doses were amplified by reactive-hormone factors. The lowest dose that leads to radioinduced damage of the lymphatic tissue is 20 to 50 r. The dose-dependent inhibition of DNA synthesis and mitosis determines the length of the inactive phase. High radiosensitivity is connected with increasingly resistant regeneration potency. After local irradiation, undamaged lymphatic and lymphoid cells migrate into the damaged tissues and require rapid repopulation. The radiosensitivity of the lymph nodes in various body areas shows variations. The damage of the lymphatic cells was determined in cytological and electron optical pictures by chromatin displacement at the nuclear membrane, nuclear compression and illumination, enlargement and disintegration of the nucleon, dilation of the nuclear membrane by skimming off of the cytoplasmic lamella, and reduction of the size, number, and matrix density of mitochondria. The modifications of the reticulum cells are expressions, partially, of the functional activation

and, partially, of radiation damage. The extent of damage and regeneration of lymphoreticular tissue was determined most accurately in the character of the number and activity of the cells synthesizing DNA. The modifications of the ferment activities in the spleen and lymph nodes are limited by the relative increase of ferment-rich cells, the enzyme induction, membrane damage, and the radio-limited inhibition of ferment production. The cells in the lymphoreticular tissue, which contribute to antibody formation, have a distinct radiosensitivity. The reticular cells which include a corpuscular antigen were significantly damaged by large whole-body doses. The development of the precursor of antibody-forming cells is inhibited above 150 r and the antibody production is therefore delayed and reduced. Precursor cells that are activated before irradiation possess increased radiation resistance. They can be induced, however, by an antigen and proliferated to plasma cells. The plasma cells themselves permit damage to the endoplasmic reticulum to be determined. 153 references. (tr-auth)

11816 RADIATION EFFECTS ON CELLS OF IMPORTANT ORGANS. HYPOPHYSIS. J. Trautmann. p.181-6 of "Strahlenpathologie der Zelle. Beiträge zur Zyto- und Histopathologie der Strahlenwirkung." Stuttgart, Georg Thieme Verlag, 1963.

Little is known of the morphological modifications of the hypophysis after irradiation. Reliable data of a chronological normal anatomy of the organism investigated are a prerequisite for the acquisition of important results. The neurohypophysis appears, in general, more radiosensitive than the adenohypophysis. Modification of the hormone regulation appears after exposure of the midbrain hypophysis region to low radiation doses. 45 references. (tr-auth)

11817 RADIATION EFFECTS ON CELLS OF IMPORTANT ORGANS. ADRENAL CORTEX. J. Trautmann. p.187-94 of "Strahlenpathologie der Zelle. Beiträge zur Zyto- und Histopathologie der Strahlenwirkung." Stuttgart, Georg Thieme Verlag, 1963.

The adrenal cortex is an organ that appears morphologically expressionless when one disregards its transformation capacity and certain histochemically detectable modifications. After whole-body and local irradiation, an increase of the adrenal cortex functions is found consistently a few hours after the exposure. 41 references. (tr-auth)

11818 RADIATION EFFECTS ON THE CELLS OF IMPORTANT ORGANS. TESTICLES. J. Trautmann. p.195-208 of "Strahlenpathologie der Zelle. Beiträge zur Zyto- und Histopathologie der Strahlenwirkung." Stuttgart, Georg Thieme Verlag, 1963.

The effects of radiation on the male germinal epithelium has been frequently studied from a morphological and genetic viewpoint in the last 60 years. The present study goes into more detail on the findings of these older writers as it is felt that their work was not sufficiently appreciated and judged in the evaluation of investigations of more recent years. The radiation sensitivity of the germinal epithelium, the effects of radiation on the weight of the testicle, and radiation effects on the functioning of the male germinal epithelium are the subjects discussed. 60 references. (J.S.R.)

11819 RADIATION EFFECTS ON CELLS OF IMPORTANT ORGANS. OVARIES. E. Jostes. p.209-32 of "Strahlenpathologie der Zelle. Beiträge zur Zyto- und Histopathologie der Strahlenwirkung." Stuttgart, Georg Thieme Verlag, 1963.

Modifications in the ovary are visible one hour after irradiation. The modifications to the nucleus of the ovum and follicle cells with displacement of the chromatin to the nuclear membrane, dilation of the nuclear membrane, and nuclear pycnosis were exceeded by the sharp changes at the cytoplasm with dilation of the ergastoplasm, vacuolization of the mitochondria, and radical reconstruction. A variable edema of nucleus and cytoplasm and of the connective tissue constituent of the ovary was found together with extravasation of blood cells. These modifications were visible two weeks after daily doses of 1.2 rad. The modifications can be interpreted as a specific immediate reaction of the ovary to ionizing radiation only to a limited extent since similar destruction can be caused by unspecific insults such as total exhaustion, hydration, dehydration, and chloroforming. Cells in a highly active metabolic state, such as follicle cells, ova, and primary follicles are especially sensitive. Oocytes of the Graf follicles rarely show morphological changes. After three weeks the destruction, especially of the epithelial constituents, is concluded. Under low doses, the structure of the ovary is essentially preserved, but perturbations in maturation of the follicle, numerous anovular follicles, and increased connective tissue constituents appear. In man 290 r, but in other mammals at least 360 r, are necessary for the destruction of the primordial follicle. Higher doses are necessary for inhibition of hormone production. 154 references. (tr-auth)

11820 RADIATION EFFECTS ON CELLS OF IMPORTANT ORGANS. LIVER. H. Braun. p.233-47 of "Strahlenpathologie der Zelle. Beiträge zur Zyto- und Histopathologie der Strahlenwirkung." Stuttgart, Georg Thieme Verlag, 1963.

Alterations in the volume and structure of the cell nuclei and nucleoli were recorded in liver cells after the application of whole-body and partial irradiations at sublethal doses. A reversible evolution of nuclear proteins in the cytoplasm was shown a short time after exposure. The number of necrotic cells is dependent on the age of the animals and can be increased by supplementary starvation of the animals. In cytoplasm a decreasing radiation sensitivity is parallel with the steady variation of the mitochondria from the center of the liver node to the periphery. The surface variations shown on isolated mitochondria can be confirmed on intact irradiated liver cells. After both lethal and sublethal doses a decrease of the endoplasmic reticulum was observed. Its cavity temporarily expands before the mitochondria. Directly after irradiation damage was detected in the external membranes and vacuoli in the interior of the organella. In addition to the spherical transformations which increases after very high doses and occurs at long time intervals after the irradiation, other forms of the structure change can occur. A transformation of mitochondria into lipid particles is not detectable, but a fatty degeneration of promitochondria is found. Degenerative and regenerative structure modifications can be observed simultaneously in one cell. The connective tissue elements are changed in the delayed reactions in irradiated liver cells. 79 references. (tr-auth)

11821 RADIATION EFFECTS ON THE CELLS OF IMPORTANT ORGANS. INTESTINE. H. Braun. p.248-64 of "Strahlenpathologie der Zelle. Beiträge zur Zyto- und Histopathologie der Strahlenwirkung." Stuttgart, Georg Thieme Verlag, 1963.

The eipthelial cells of the intestine are the site of severe and potentially lethal radiation damage. By disturbance of the proliferative cell cycle a series of pathological modifi-

cations was caused, which work in opposition to several protective mechanisms. It was shown that the motion of cells released at the vilous tip could be maintained by radiation burden. After high doses, cells always move out from the crypt in order to counteract the premature stripping of the intestinal villi. This emigration of cells is, however, not possible under all conditions, but the crypt cells must have obtained a given stage in the proliferative cycle. Further mechanisms, which control the emergence of cells from the crypt, can be assumed. Data indicate a possible relation between the supposed control mechanisms and DNA synthesis. If cells of various radiation sensitivities in the intestinal epithelium are compared, a decrease of the sensitivity is observed with increasing cytoplasmic differentiation. Electromicroscopic results show that less radiosensitive cells of the intestinal epithelium show an immediate reaction at the cytoplasmic organella which can lead through hydropic swelling to transient formation of membranes and granular structures. In cells that have passed through a disturbed maturation process, the plasmic structure loss can lead to cell death after higher doses. 46 references. (tr-auth)

11822 RADIATION EFFECTS ON THE CELLS OF IMPORTANT ORGANS. LUNGS. D. R. Holsten. p.265-76 of "Strahlenpathologie der Zelle. Beitrĕge zur Zyto- und Histopathologie der Strahlenwirkung." Stuttgart, Georg Thieme Verlag, 1963.

The radioinduced modifications in the lungs can be divided into an early stage, principal stage, regeneration stage, and fibrotic stage. Histologically, an alveolar edema and a hyperemia and swelling of the interstitial tissues are found after irradiation. A thickening of the connective tissues occurs later in the alveolar and iterlobar septa. The alveolar epithelia are atypically unchanged. Small atelectatic regions appear. The vessel and bronchial walls are altered. The pleura is thickened. The radiation effects on the alveolar and capillary cells is the prime origin for the first modifications appearing. The modifications occurring as a result of gamma irradiation correspond to those arising from x irradiation. In studies on the relative biological effectiveness of x ray, Co^{60}, and 17-Mev electrons, a phase displacement in the reaction pattern can be established for the different radiations at fractionated applications of 3000 r. Some factors affecting radiation injury are indicated. 53 references. (tr-auth)

11823 RADIATION EFFECTS ON THE CELLS OF IMPORTANT ORGANS. KIDNEYS. U. Feine. p.277-91 of "Strahlenpathologie der Zelle. Beitrĕge zur Zyto- und Histopathologie der Strahlenwirkung." Stuttgart, Georg Thieme Verlag, 1963.

The kidneys are one of the most radio-resistant organs. Functionally strongly stressed cytoplastic structures are more resistant than the nucleus in its division stage: significant damage occurring first over 1500 r and after a dose-dependent latency time. Radiation reactions observed under these conditions are probably of a secondary nature and arise through irradiation of large parts of neighboring organs. The latency time in the radiation injury to the kidneys is especially easy to observe on the cytoplasm. By reduction of the radiation dose, a prolongation of the symptom-free phase is present. For single exposures a dose threshold can be established. In man, about 2000 r localized dose is the thresbold value for fractionated exposure. 49 references. (tr-auth)

11824 RADIATION EFFECTS ON THE CELLS OF IMPORTANT ORGANS. CENTRAL NERVOUS SYSTEM. N. Schuemmelfeder. p.292-316 of "Strahlenpathologie der Zelle. Beitrĕge zur Zyto- und Histopathologie der Strahlenwirkung." Stuttgart, Georg Thieme Verlag, 1963.

The pattern of radiation injury in the central nervous system is discussed, and the acute radiation necrosis, the early damage with selective or partial parenchymatous necrosis, and the delayed radiation necrosis are described. The patho- and morphogenesis of the damage is considered. 90 references. (J.S.R.)

11825 RADIATION EFFECTS ON THE CELLS OF IMPORTANT ORGANS. SKIN. K. H. Kaercher. p.317-33 of "Strahlenpathologie der Zelle. Beitrĕge zur Zyto- und Histopathologie der Strahlenwirkung." Stuttgart, Georg Thieme Verlag, 1963.

With the introduction of histochemical and ferment histochemical investigations and quantitative ferment determinations, new insights can be obtained into the nature and dynamics of the pattern of radiation reactions. Both the behavior of acid and neutral mucopolysaccharides and the alterations in the region of energy metabolism of the epidermis and the synthesis of nuclear and plasma protein constituents after irradiation are essential knowledge in the clarification of the relation of biological reactions to ionizing radiation. The histochemical localization of the hydrogen-carrying ferments of energy metabolism showed, in agreement with quantitative determinations, a temporary decrease of the ferment activity, principally malate dehydrogenase. This investigation suggests that histochemical and quantitative analyses together with biochemical methods will yield further clarification on the mechanism of the radiation reaction. 32 references. (tr-auth)

11826 RADIATION EFFECTS ON TUMOR CELLS. H. K. Parchwitz. p.334-63 of "Strahlenpathologie der Zelle. Beitrĕge zur Zyto- und Histopathologie der Strahlenwirkung." Stuttgart, Georg Thieme Verlag, 1963.

The radiogenic alterations found in normal cells and their constituents can not be transferred directly to the radioinduced reactions of tumor cells. The morphological aspects of radiation effects are first reviewed generally and then illustrated in some detail, using the Walker carcinoma cell as an example. 110 references. (J.S.R.)

11827 THE MANIFESTATION OF CELLULAR RADIATION DAMAGE. CONCLUDING REMARKS. E. Scherer and H. St. Stender. p.364-81 of "Strahlenpathologie der Zelle. Beitrĕge zur Zyto- und Histopathologie der Strahlenwirkung." Stuttgart, Georg Thieme Verlag, 1963.

The radiation damage to the cell is visible in a number of morphological and biochemical modifications, of which a survey was given. The general cell damage is shown by acute and delayed cell death, inhibition of mitosis, and cell loss. The alterations of the structural elements of the cell after irradiation—cell nucleus, nucleolus, nuclear membrane, mitochondria, endoplasmic reticulum, Golgi organs, DNA, and the ferment system—are summarized. 119 references. (J.S.R.)

11828 REPAIR FROM GENETIC RADIATION DAMAGE AND DIFFERENTIAL RADIOSENSITIVITY IN GERM CELLS. Proceedings of an International Symposium held at the University of Leiden, the Netherlands, August 15-19, 1962. F. H. Sobels, ed. A Pergamon Press Book. New York, The Macmillan Company, 1963. 463p.

Twenty-four articles are included; separate abstracts were prepared for 15. Nine articles previously abstracted in NSA include information on: effect of gametic genotype on the radiosensitivity of Drosophila sperm; stage sensi-

tivity to x radiation during meiosis and mitosis in Habrobracon egg; relation of repair to differential radiosensitivity in the production of mutations in Paramecium; differential yields of mutations from the first and second matings after irradiation of mature sperm in D. melanogaster; chronic and acute gamma irradiation in Drosophila; relative sensitivity of various germ-cell stages of the mouse to radioinduced non-disjunction, chromosome losses, and deficiencies; dose-dependence of the frequency of radioinduced recessive sex-linked lethals in D. melanogaster, with special consideration of the stage sensitivity of the irradiated germ cells; repair and differential sensitivity to mutation induction; and kinetics for two-break chromosome exchanges and the ½ power rule. (P.C.H.)

For abstracts of individual papers see: 11829, 11830, 11831, 11832, 11833, 11834, 11835, 11836, 11837, 11838, 11839, 11840, 11841, 11842, and 11887.

11829 ON THE NATURE OF SENSITIVITY CHANGES IN OOCYTES OF DROSOPHILA MELANOGASTER. D. R. Parker (National Science Foundation, Washington, D. C. and Univ. of California, Riverside). p.11-19 of "Repair from Genetic Radiation Damage." New York, The Macmillan Co., 1963.

Changes in sensitivity in stages 7 and 14 of primary oocytes of Drosophila were studied with special attention on detachments of attached X chromosomes and the induction of dominant and recessive lethals. Changes in sensitivity between stages 7 and 14 are not simple. In the case of rearrangement, the increase involves a disproportionate increase in the value of k, and the total increase is underestimated due to the greater proportion of inviable aneuploids occurring in the later stage. The increase in sensitivity is accompanied by much less rapid rejoining, and this may be the principal basis for the increase in the value of k, through a lowering of the probability of restitution. In the case of dominant lethals, there is a change in the mode of their production, it being a two-hit process in the early stage, becoming one-hit later. The delay in rejoining may be the primary cause, dominant lethals in stage 14 arising from breaks that do not restitute or rejoin. The increase in frequency of recessive lethals seems primarily dependent on the increased frequency of two-hit events, hence may be due to an increased production of chromosomal aberrations, perhaps small deficiencies. (P.C.H.)

11830 POSSIBLE REASONS FOR VARIATION IN CHROMOSOME RADIOSENSITIVITY DURING MITOTIC AND MEIOTIC CYCLES. H. J. Evans (Medical Research Center, Harwell, Berks, Eng.). p.31-49 of "Repair from Genetic Radiation Damage." New York, The Macmillan Co., 1963.

A re-examination of some of the extensive data available on aberration frequencies in plant materials was carried out in an attempt to determine the principal causes for variation in chromosome sensitivity during mitotic and meiotic cycles. It was concluded that a major portion of the increased sensitivity of the chromosomes as they proceed to, and pass through, division may be due to three factors: chromosome duplication; changes in oxidative metabolism associated with the entry of cells into division; and changes in the levels of SH compounds during the organization of the mitotic or meiotic apparatus. (auth)

11831 THE MUTATIONAL SPECTRUM WITH SPECIAL REFERENCE TO THE INDUCTION OF MOSAICS. Irwin I. Oster (Inst. for Cancer Research, Philadelphia). p.51-58 of "Repair from Genetic Radiation Damage." New York, The Macmillan Co., 1963.

By the use of special multipurpose stocks of Drosophila melanogaster and refined breeding techniques the effects of several conditions existing at the time of irradiation were investigated. In addition to information gained concerning the frequencies of induced chromosome breakage, lethal mutations, and translocations, which were in line with previous results, it was found that gamma rays, x rays in air or oxygen, and neutrons produce relatively low frequencies of mosaic mutations while irradiation under anoxic conditions results in fairly high proportions of mosaic individuals. (auth)

11832 MUTATION RATES DURING THE MEIOTIC PROCESS IN YEASTS. G. E. Magni (Università, Pavia). p.77-85 of "Repair from Genetic Radiation Damage." New York, The Macmillan Co., 1963.

A new method for the comparison of mutation rates occurring during the mitotic and meiotic processes is presented. It allows the estimate of mutation rates on a per cell basis and on the same type of cells (yeast) undergoing either one of the two division processes. It was observed that mutation rates from dependence to independence for three unrelated biochemical requirements are from 8 to 20 times higher in meiosis than during mitosis. Variations of mutability induced by x rays and ultraviolet during the meiotic process were also studied. A sensitive period to mutations induced by both kinds of radiation was found. It corresponds probably to the last stages of second meiotic division. (auth)

11833 VARIATION OF RADIOSENSITIVITY DURING MEIOSIS AND EARLY CLEAVAGE IN NEWLY LAID EGGS OF DROSOPHILA MELANOGASTER. F. E. Wuergler, H. Ulrich, and A. Schneider-Minder (Swiss Federal Inst. of Tech., Zürich). p.101-6 of "Repair from Genetic Radiation Damage." New York, The Macmillan Co., 1963.

Newly laid eggs of D. melanogaster were irradiated (500 r of 50-kev x rays) at different ages being kept at 24.4°C from oviposition until completion of irradiation. The sensitivity was found to vary strongly during the first 30 min of development. Peaks of radiosensitivity (high embryonic mortality) were found in late anaphase/early telophase of meiosis II and of every cleavage division analyzed. The relatively lowest radiosensitivity appeared in the pronucleus and in the interphase stages. In order to gain information on the types of nuclear damage and on their contribution towards the sum embryonic mortality dose action curves as every stage during the first half hour of development were recorded. (P.C.H.)

11834 REPAIR OF LETHAL ULTRAVIOLET DAMAGE IN PHAGE DNA. Walter Harm (Universitat, Cologne). p.107-18 of "Repair from Genetic Radiation Damage." New York, The Macmillan Co., 1963.

Specific repair phenomena in uv damaged DNA in bacteriophages are reviewed. Some results concerning the mechanisms of the different phenomena and the relation between them are discussed. The repair phenomena discussed include photo-, v-gene, host-cell (HCR), and uv reactivation. It is suggested that in all cases the uv survival of unsubstituted DNA involves HCR. (P.C.H.)

11835 ULTRAVIOLET LIGHT-INDUCED MUTATION AS AN EVENT IN THE PHYSIOLOGY OF THE BACTERIAL CELL. C. O. Doudney (Univ. of Texas, Houston). p.125-49 of "Repair from Genetic Radiation Damage." New York, The Macmillan Co., 1963.

Through a concurrent investigation of the nonlinearity of

the uv induced mutation curve in strain WP2 and recovery of DNA synthesis in the same organism following various levels of exposure to uv, evidence was obtained to support the hypothesis that two radiation effects are involved in uv-induced mutation. The effects are: blockage of DNA synthesis by uv causing a requirement for RNA and protein synthesis in repair of the uv-damaged DNA synthetic system and the establishment of the photochemical modification (the mutation lesion) that results in mutation with DNA replication. Utilizing log phase cultures of E. coli WP2, a parallel effect of pre-irradiation blockage of protein synthesis in lowering mutation frequency response to uv was demonstrated to that obtained in postirradiation studies. Furthermore, the period of time required for this effect is comparable in duration to the time required for the post-irradiation-induced mutation frequency decline process. The time required to eliminate the maximum number of mutations is identical in duration to the time required to produce that physiological stage in bacteria in which DNA synthesis cannot take place in the absence of protein synthesis. The results suggest that the mutation frequency decline process is not directly involved in the elimination of the potential mutation, as hitherto assumed, but rather is a physiological effect of blockage of protein synthesis that eliminates the capacity for mutation response to uv. The evidence suggests that the physiological condition that prevents mutation response to uv is the completion of the cellular DNA replication cycle making further protein synthesis necessary before DNA can be formed. A working model for a uv-induced mutation in bacteria is presented. (P.C.H.)

11836 "DARK REPAIR" OF MUTATIONS INDUCED IN ESCHERICHIA COLI BY ULTRAVIOLET LIGHT. Evelyn M. Witkin (State Univ. of New York, Brooklyn). p.151-61 of "Repair from Genetic Radiation Damage." New York, The Macmillan Co., 1963.

After irradiation with a series of uv doses, the same fraction of the potential induced prototrophs may be eliminated by exposure to photoreactivating light (PRL) or by incubation in an amino acid-free medium in the dark. This suggests that the two post-treatments promote repair of the same initial lesions. Thus, it seems likely that amino acid deprivation fosters an alternative means of effecting the same repair, and that the lesions leading to induced prototrophy are produced in DNA. Experiments in which starvation for thymine was used to prevent DNA synthesis confirm the finding that potential mutations are irreversibly stabilized, or fixed, only if DNA replication is permitted. As long as DNA synthesis is prevented, the yield of prototrophs remains reducible by challenge with amino acid-deprivation. Potential prototrophs may lose their susceptibility to different antimutagenic post-treatments at very different rates. It is argued that loss of susceptibility to a particular post-treatment is not an adequate criterion of fixation, if the latter is defined as the irreversible stabilization of a potential mutation. A potential mutation may be considered fixed, in this sense, only when no post-treatment is capable of influencing the mutation frequency. By this criterion, the terminal event in the pathway of mutation to uv-induced prototrophy is clearly the first post-irradiation replication of DNA. The possibility was examined that potential mutations are stabilized by amino acids through combination of the latter with coded nucleotide sequences reflecting gene specificity. No indication was obtained of locus-specific patterns of amino acids required for stabilization of induced prototrophs at two different loci in the same strain. It is pointed out, however, that such differences might be expected only if the two loci under investigation code for polypeptide chains differing qualitatively from each other. (P.C.H.)

11837 THE EFFECT OF RADIATION DOSE RATE AND FRACTIONATION ON MUTATION IN MICE. W. L. Russell (Oak Ridge National Lab., Tenn.). p.205-17 of "Repair from Genetic Radiation Damage." New York, The Macmillan Co., 1963.

A review is presented on the effects of dose rate variation and dose fractionation of continuous irradiation in mice. Discussion is restricted to data obtained with the specific locus method. It was concluded that the dose-rate effect on mutation is an intracellular phenomenon, rather than a secondary effect of some other process, such as a cell population change. This indicates that, at low-dose rates, some repair or prevention of the genetic damage is occurring. Repair of premutational damage is suggested as a probable mechanism. (P.C.H.)

11838 THE EFFECT OF INTENSITY AND FRACTIONATION ON RADIATION-INDUCED MUTATION IN DROSOPHILA. C. E. Purdom (Medical Research Center, Harwell, Berks, Eng.). p.219-30 of "Repair from Genetic Radiation Damage." New York, The Macmillan Co., 1963.

The effect of radiation intensity on the induction of mutation was studied in Drosophila. Male germ cells were exposed to radiation intensities ranging from 0.01 to 2.6 r/min. No intensity effect was observed when irradiaion was received primarily by spermatocytes and spermatids. Similarly, no intensity effect was observed in spermatogonia over the range 0.05 to 2.6 r/min. Irradiation at 0.01 r/min did, however, produce a significantly low mutation frequency in one experiment. This may indicate the presence, at very low dose-rates, of an intensity effect in spermatogonia, but the single observation was not regarded as conclusive. Attempts to examine the effect of dose-fractionation in the light of possible intensity effects were rendered inconclusive by the absence of an intensity effect in parallel experiments. (auth)

11839 DIFFERENTIAL RADIATION-SENSITIVITY OF GERM CELLS AS A POSSIBLE INTERPRETATION OF SEX DIFFERENCE IN DOSE-RATE DEPENDENCE OF INDUCED MUTATION RATES IN THE SILKWORM. Yataro Tazima and Sohei Kondo (National Inst. of Genetics, Misima, Japan). p.237-52 of "Repair from Genetic Radiation Damage." New York, The Macmillan Co., 1963.

In order to elucidate the difference in sex with respect to mutation response of silkworm germ cells, experiments were carried out on silkworms. The dose-mutation frequency relationship was followed up by irradiating spermatogonia and oögonia with acute (316 ~ 333 r/min) or chronic (0.069 ~ 0.208 r/min) irradiation at the earliest larval stage. The shape of the dose-frequency curves was different between spermatogonia and oögonia. In oögonia a linear relationship was clearly observed for both acute and chronic irradiation, while in spermatogonia the frequencies for acute and chronic exposures increased with the increase of dose more rapidly than expected for linearity; the dose rate difference becoming smaller in the high dose range. Survival of irradiated germ cells was estimated by analyzing theoretically the frequency distribution of the number of recovered mutants per mating pair. Comparison in LD_{50} between spermatogonia and oögonia clearly showed that spermatogonia are twice as sensitive to radiation as oögonia. It was concluded that the dose-rate dependence of radioinduced mutation rate is closely correlated to the killing effect of radiation, and hence to the sensitivity of germ

cells. The significance of these phenomena in the process of recovery of primary mutational damage is discussed. (P.C.H.)

11840 CELL STAGES AND DIFFERENTIAL SENSITIVITY TO IRRADIATION IN MALES OF DROSOPHILA MELANOGASTER. Ruth Saevhagen (Univ. of Stockholm). p.343-57 of "Repair from Genetic Radiation Damage." New York, The Macmillan Co., 1963.

By simultaneous studies of paternal non-disjunction and a certain type of chromosome aberration in Drosophila the brood pattern was correlated with the early meiotic stages in spermatogenesis, prior to anaphase I. It was shown that the cells treated in meiosis became available for insemination during the 7–10th day after irradiation. The peak of sensitivity to irradiation measured through induced XO males of XXO females, coincides with the peak of induced paternal nondisjunction and thus with cells treated in early meiosis. About the same sensitivity pattern is obtained after irradiation of 0–1 and 3–4-day-old males. There is, however, a difference in the amplitude of sensitivity. Thus the frequency of both XO males and induced non-disjunction females is much lower in experiments with 3–4-day-old males. When comparing the different methods used in order to demonstrate the genetic effects (damage) of irradiation it is evident that there is not only a marked difference in sensitivity to irradiation between various stages of spermatogenesis in Drosophila, but also a difference in sensitivity pattern depending on the type of aberration studied. Hence the differences in the sensitivity patterns reflect the relationship between the mechanisms at work in producing different kinds of damage and the cell stage treated. The relationship between induced genetic changes and oxygen concentration in various stages of spermato- and spermiogenesis was studied. The effect after irradiation in nitrogen atmosphere reveals that anoxia exerts the most striking influence upon the yield of XO males during the period of highest sensitivity to x irradiation. Irradiation in commercial oxygen affects the sensitive stages in different ways in 0–1 and 3–4-day-old males. In the younger males there is a lower effect than that obtained after irradiation in air, while in 3–4-day-old males there is a correspondingly higher rate of chromosome losses. (auth)

11841 CYTOLOGICAL EVALUATION OF DIFFERENTIAL RADIOSENSITIVITY IN SPERMATOGENOUS CELLS OF DROSOPHILA. Berwind P. Kaufmann and Helen Gay (Carnegie Institution of Washington, D. C. and Long Island Biological Assn., Cold Spring Harbor, N. Y.). p.375-408 of "Repair from Genetic Radiation Damage." New York, The Macmillan Co., 1963.

The radiosensitivity of spermatogenous cells of Drosophila as studied by cytologists and cytogeneticists is reviewed. Radioautographic chronometry, structural changes predisposing to differential radiosensitivity, and the effects of radiations on DNA and on the nucleoprotein complex that constitutes the chromosome are discussed. 93 references are included. (P.C.H.)

11842 POST-IRRADIATION MODIFICATION OF GENETIC EFFECTS IN PLANT SEEDS. A. T. Natarajan and K. R. Narayanan (Indian Agricultural Research Inst., New Delhi, India). p.413-26 of "Repair from Genetic Radiation Damage." New York, The Macmillan Co., 1963.

When barley seeds are irradiated at 20°C and germinated initially at different temperatures, the various radiation responses like growth inhibition, chromosome breakage, seed fertility, mutation frequency, can be modified to a different extent for a given dose. A cold temperature post-treatment can thus increase mutation frequency effectively. A similar response can also be demonstrated for fast neutrons (for chromosome aberrations and growth inhibition). The proportion of exchanges to simple breaks increases with decrease in temperature in the case of x rays, whereas in the case of neutrons, though there is a quantitative difference in the yield of aberrations, the proportion of exchanges to simple breaks remains the same. The fact that the chromosome breaks induced by fast neutrons and x rays can interact, indicates that they are not qualitatively different and only the spatial arrangement of the breaks may account for the difference that is usually observed between them, that is the non-modifiability of neutron-induced breaks. (auth)

Radiation Effects Therapy and Countermeasures

11843 (NP-13555(p.46-63)) PHARMACOLOGICAL AND TOXICOLOGICAL COMPOUNDS AS PROTECTIVE OR THERAPEUTIC AGENTS AGAINST RADIATION INJURY IN EXPERIMENTAL ANIMALS. I. THE INFLUENCE OF VARIOUS CHEMICAL COMPOUNDS ON RADIATION LETHALITY IN MICE. V. J. Plzak, M. Root, and J. Doull (Chicago. Univ. Air Force Radiation Lab.).

Thirty-one compounds were evaluated for protective activity against radiation lethality in mice. The best protection was afforded by PD-31, a thiopseudourea derivative. Data are included on the chemical formula, toxicity, and radioprotective effect of all compounds. (C.H.)

11844 (NP-13555(p.64-83)) PHARMACOLOGICAL AND TOXICOLOGICAL COMPOUNDS AS PROTECTIVE OR THERAPEUTIC AGENTS AGAINST RADIATION INJURY IN EXPERIMENTAL ANIMALS. II. THERAPY OF RADIATION INJURY IN MICE WITH CHEMICAL AGENTS. J. Dilley, J. Doull, and Eric L. Simmons (Chicago. Univ. Air Force Radiation Lab.).

The administration of potassium cyanide or sodium sulfite 30 min after exposure to lethal doses of whole-body x radiation produced a small but significant increase in the survival of female CF_1 mice. The administration of these agents in combination had no apparent advantage over using either one alone. The post-irradiation administration of sodium thioglycolate, 2-aminothiazole, 2,4-thiazolidinedione, and thiazolidine-4-carboxylic acid significantly increased the survival time of female CF_1 mice exposed to lethal doses of whole-body x radiation but not so effectively as 2-iminothiazolidine-4-carboxylic acid. With the dose of sodium thiocyanate used, it was not possible to demonstrate a similar effect. The combination of bone marrow cells and 2-iminothiazolidine-4-carboxylic acid given after supra-lethal doses of whole-body x radiation did not seem to enhance the recovery of the hematopoietic system over animals treated with bone marrow cells alone in female CF_1 mice. However, the thiazolidine did seem to prevent the formation of a fatty liver during the post-irradiation period in female mice under these experimental conditions. It seemed, therefore, that the therapeutic mechanism involved in the increased survival of lethally irradiated female CF_1 mice, using 2-iminothiazolidine-4-carboxylic acid, is of a more fundamental nature than the stimulation of an increase in the rate of cell division in the hematopoietic system. There appeared to be a threshold level for bone marrow cells given to female CF_1 mice, above which the

presence of the thiazolidine derivative was detrimental to the survival of the animal, under the experimental conditions. (auth)

11845 (NP-13555(p.84-95)) PHARMACOLOGICAL AND TOXICOLOGICAL COMPOUNDS AS PROTECTIVE OR THERAPEUTIC AGENTS AGAINST RADIATION INJURY IN EXPERIMENTAL ANIMALS. III. HISTOPATHOLOGICAL FINDINGS IN THE TISSUES OF X-RAYED MICE TREATED WITH COMBINATIONS OF HOMOLOGOUS BONE MARROW AND 2-IMINO-THIAZOLIDINE-4-CARBOXYLIC ACID. D. Vesselinovitch, J. Dilley, F. Fitch, J. Meskauskas, and J. Doull (Chicago. Univ. Air Force Radiation Lab.).

A comparison was made of the histopathology in the hematopoietic tissues of mice given 900 r of whole-body x irradiation followed by treatment with homologous bone marrow or with a combination of bone marrow and 2-imino-thiazolidine-4-carboxylic acid. Marked destruction of the spleen, thymus, lymph nodes, and bone marrow was observed in both the control and treated group of animals. These changes were similar in all of the groups during the first few days after the x-ray exposure, but starting on the third post-irradiation day evidence of regenerative processes was observed in the hematopoietic tissues of the treated animals. There was little or no indication of recovery in the tissue of the mice given the x-ray exposure without subsequent treatment. The administration of 2-iminothiazolidine-4-carboxylic acid at 30 min following the administration of a therapeutic dose of homologous bone marrow to x-rayed mice did not markedly alter either the onset of recovery or the degree of recovery in the hematopoietic tissues of these animals. (auth)

11846 (NP-13555(p.96-106)) PHARMACOLOGICAL AND TOXICOLOGICAL COMPOUNDS AS PROTECTIVE OR THERAPEUTIC AGENTS AGAINST RADIATION INJURY IN EXPERIMENTAL ANIMALS. IV. COMPARISON AND ANALYSIS OF PROTECTIVE EFFECTIVENESS OF AET DERIVATIVES. D. G. Oldfield, V. Pizak, and J. Doull (Chicago. Univ. Air Force Radiation Lab.).

An analysis of maximum likelihood estimates of 30-day mean lethal dose and other parameters calculated using IBM 7094 for mice total-body irradiated by 250 kvp x rays with and without pre-irradiation treatment with several derivatives of AET was made. The results showed qualitative agreement with the concept that protection increased as the probability of transguanylation increased, and as the electronegativity of the beta nitrogen of the guanidine group increased. A simple quantitative model of chemical radioprotection was proposed and relations to observed indices of protector effectiveness were derived. (auth)

11847 (NP-13555(p.118-30)) THE INFLUENCE OF EXPOSURE TO LOW LEVELS OF GAMMA AND FAST NEUTRON IRRADIATION ON THE LIFE SPAN OF ANIMALS. II. TIME-INDEPENDENCE OF DOSE REDUCTION FACTORS IN PROTON- OR X-RAY-IRRADIATED MICE PRETREATED WITH MEA OR PAPP. D. G. Oldfield, V. Pizak, and J. Doull (Chicago. Univ. Air Force Radiation Lab.).

Maximum likelihood estimates of mean lethal dose and other parameters were calculated (IBM 7094) for each of several different times of lethality assay in mice total-body irradiated by high-energy (440-Mev) protons or by medium energy (250-kvp) x rays with and without pre-irradiation treatment with 2-mercaptoethylamine hydrochloride (MEA) or p-aminopropiophenone (PAPP). The mean lethal dose decreased continuously as time of assay increased from 12 to 70 days in all control and treated groups. The dose reduction factor remained approximately constant from 21 to 70 days. A small but reproducible and stable reversal of protector effectiveness was demonstrated in the experimental system used. Specifically, on the basis of DRF, and for the drug dosages used, MEA was a better protector than PAPP against high-energy proton irradiation, but a poorer protector than PAPP against medium energy x-ray irradiation, at all post-irradiation times from 12 to 70 days. Possible causes of the reversal effect are discussed on the basis of a model for chemical protection. (auth)

11848 (UCLA-520(p.53-74)) NUCLEAR MEDICINE. (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology).

High specific activity I^{131}-albumin preparations were used for lung scans and measurements of pulmonary blood flow in patients with pulmonary embolism, pulmonary atelectosis, acute bacterial pneumonia, chronic pulmonary tuberculosis, lung abscesses, pulmonary cysts, emphysema, and bronchogenic and metastatic carcinoma of the lungs or liver. Nearly all the scans on 25 patients disclosed information of clinical and diagnostic value. These preliminary studies suggest that the lung scan is useful in revealing abnormalities of the pulmonary circulation that are most difficult to diagnose by standard radiographic techniques. In several cases it was possible to demonstrate small pulmonary emboli before infarction developed. Preliminary data are included from studies of heart stroke volume in phantoms, dogs, and humans after the injection of I^{131}-labeled serum albumin; the transfer of Ca^{45} between mother and fetus in pregnant rhesus monkeys; the development of a tetrazolium blue-gelatin dosimeter for high level γ measurements; the radiosensitivity of mice exposed in the center of a Co^{60} γ source; the effect of dose rate on the protective effects of AET and 5-HT in mice; and the role of DNA and the thymus in leukemogenesis in mice. (C.H.)

11849 VALUE OF RADIOPROTECTIVE SUBSTANCES IN THE LIGHT OF RECENT RADIOBIOLOGICAL RESEARCHES. Z. Zsebok. Acta Chir. Acad. Sci. Hung., 3: XXI-XXXI(1962).

The literature relating to the effectiveness of chemical and biological radioprotective agents is reviewed. (BBB)

11850 RADIATION DAMAGE OF SERUM IN THE PRESENCE OF PROTECTIVE AGENTS BY THERMAL NEUTRONS AND X RAYS. Aubin Hendrickx (Rijksuniversiteit, Ghent). Acta Pharmacol. Toxicol., 15: 251-6 (1959).

As an approach to understanding the mechanism underlying radioprotection by sulfhydryl agents, serum levels of sulfhydryl (-SH) and disulfide (-S-S-) groups were measured, and their reaction to thermal neutrons and γ rays in the presence of a protective agent, such as cysteine, cystine, cysteinamine, and cystamine was studied. It was shown that serum contains reactive -S-S- groups, and that the reactivity of -SH and -S-S- varies with the age of the serum donor. Cystine and serum behave differently under the influence of radiation; cystine is destroyed, whereas serum shows an increase in titrable -SH and -S-S- groups. The serum in a 5-ml Pyrex vessel was irradiated for various periods with a 1 g Ra–Be source. In an air-free aqueous solution cysteine is resistant to radiation; an initial concentration of 12.46 mg -SH/100 ml decreased only to a value of 11.61 mg after 120-minutes irradiation. Cys-

teinamine with an initial value of 14.64 decreased to 3.63 mg -SH/100 ml; thus it decomposes much more rapidly than cysteine. With cystine, 3.02 mg -SH/100 ml appeared after 120 min. Here -SH groups appeared which were not found before irradiation. The same phenomenon occurred in experiments with cystamine. The cysteine reaction in the presence of serum showed the presence of fewer -SH groups even when there was no irradiation. Cysteinamine and serum reacted in a similar way to cysteine and serum. On irradiating cysteine solutions, no -S-S- groups could be detected after various periods of irradiation up to 120 min. This indicates that under the experimental conditions used, cysteine is not oxidized in presence of neutrons or γ rays. Cysteinamine behaved similarly. On adding cysteine to serum the initial value of 4.80 mg -S-S-/100 ml rose to 7.40 mg -S-S-/100 ml after 120-minutes irradiation. With cysteinamine and serum the initial value of 1.44 mg -S-S-/100 ml was increased to 6.70 mg -S-S-/100 ml after 120 minutes irradiation. On irradiating serum the amount of -S-S- increased from 4.65 mg/100 ml to 6.24 mg/100 ml after 120 minutes. On adding cystine, cystamine, or cysteamine to serum the amount of -S-S- groups that could be detected without any irradiation was lowered. This can be explained by complex formation. Thus it was shown that on adding the radioprotective agents cystine, cysteine, or cystamine to serum, a precipitate formed before irradiation had taken place. After centrifugation and analysis of the -SH and -S-S- content in the supernatant fluid the original amounts of -SH and -S-S- were found. It was therefore concluded that all titratable -SH and -S-S- groups are absent from the precipitate. In the experiments with aerated solutions an increased amount of -S-S- was noted when serum was irradiated in the presence of cysteine or cystamine. The reaction scheme is therefore more complicated than was thought by some radiobiologists. It cannot be restricted simply to peroxide or free radical formation. Complex formation and steric structural relations of the protein, play a more important part. The effect of thermal neutrons and γ rays on the behavior of -SH and -S-S- groups in albumin differs from that on the whole serum. (BBB)

11851 RADIOPROTECTIVE EFFECTS OF S-PHOSPHORYLATED THIOLS. Stig Åkerfeldt (Research Inst. of National Defence, Sundbyberg, Sweden). Acta Radiol. (N. S.), 1: 465-70(Dec. 1963).

Fourteen different S-phosphorylated thiols were investigated as to their radioprotective properties in mice. The distribution of intraperitoneally injected cysteamine S-phosphate in certain organs of rats and mice and the urinary excretion products of cysteamine S-phosphate were also examined. (auth)

11852 PROTECTIVE EFFECT OF CYSTEAMINE AT FRACTIONATED IRRADIATION. I. LETHALITY UP TO 30 DAYS AFTER LAST IRRADIATION. Arne Nelson, Ola Hertzberg, and Inga-Britt Henricsson (Research Inst. of National Defence, Sundbyberg, Sweden). Acta Radiol. (N.S.), 1: 471-83(Dec. 1963).

Groups of mice were exposed to fraction doses at various time intervals in order to investigate the protective effect of cysteamine at sublethal levels of irradiation. Half the number of animals were given cysteamine before each irradiation. A simple mathematical model, which fitted the results regarding the short term lethal effects, was used. Cysteamine appears to act by producing a dose reduction effect and not an enhancement of the recovery. (auth)

11853 CHEMICAL RADIOPROTECTION. G. S. Melville, G. W. Harrison, Jr., and K. M. Gallo (Univ. of Texas, Austin). Aerospace Med., 34: 938-41(Oct. 1963).

Radioprotection by the use of a combination of 5-hydroxytryptamine (5-HT) and acetylcholine, a parasympathomimetic agent, is reported. The form in which 5-HT is administered may alter its effect as a protectant against acute radiation doses, both the creatinine sulfate and the picrate hydrate were used. The protection afforded rats exposed to Co^{60} γ rays by the individual drugs and the combinations with acetylcholine were studied at 1250 r of acute whole-body irradiation using 157 rats. Both forms of 5-HT as well as their combinations with acetylcholine provided extended mean survival times. Mortality distribution and per cent survival at 30 days postirradiation showed that 5-HT given alone resulted in toxic deaths, with the creatinine sulfate form contributing more heavily than the picrate hydrate. Neither acetylcholine nor creatinine alone or in combination afforded significant protection at this radiation dose when compared to the controls. The 30-day survival was significantly greater for acetylcholine plus 5-HT creatinine sulfate as compared to 5-HT creatinine sulfate alone. A comparison of death order also showed a significantly greater protective effect for the combination of drugs when compared to 5-HT creatinine sulfate. To observe the relation between mortality and radiation dose over the entire lethal range, animals were exposed to various doses, the data recorded, and regression lines drawn. The dose reduction factor at LD 50/30 is 1.503 for the combination of drugs, 1.445 for 5-HT creatinine sulfate, and 1.087 for acetylcholine. A study of the protective effect of 5-HT creatinine sulfate against chronic whole-body radiation was also made. Mortality and mean survival times were 0% and 30 days in drug-treated and 45% and 20 days in untreated groups. It was concluded that the protective effect of 5-HT creatinine sulfate combined with acetylcholine against acute whole-body irradiation is appreciably greater than that of either agent alone. (TCO)

11854 ABOUT THE EFFECTS OF SYMPATHYCOMIMETICS IN IRRADIATED ANIMALS. V. Grossmann and H. Dyntarova (Charles Univ., Hradec Kralove, Czechoslovakia). Cesk. Fysiol., 12: 358-9(Oct. 1963).

The influence of adrenaline on the blood pressure of irradiated rats was studied. The effect was lower on the 3rd and 6th day after irradiation. (OTS)

11855 INFLUENCE OF SOME NORMAL AND SOME ATYPICAL NUCLEOTIDES AND NUCLEOSIDES ON REGENERATION OF BONE MARROW AFTER IRRADIATION. Z. Karpfel, J. Slotova, and G. Blazicek (Inst. for Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 12: 373(Oct. 1963).

Pyrimidine desoxyribonucleotides were found to have a favorable effect on irradiated bone marrow. Vitamin B_{12} (containing an atypical nucleotide in its structure), reacts in the same way. The role of the number of phosphate groups was studied without any conclusive results. (TCO)

11856 INFLUENCE OF LONG LASTING HYPOTHERMY AND LOW OXYGEN INTAKE FOLLOWING IRRADIATION UPON THE EXTENT OF HEMATOLOGICAL CHANGES IN MICE. M. Praslicka and J. Horak (Safarik Univ., Kosice, Czechoslovakia). Cesk. Fysiol., 12: 386-7 (Oct. 1963).

Low temperature substantially delays decomposition of bone marrow after irradiation. (OTS)

11857 RADIOSENSITIVE STIMULANT OF GROWTH AFTER PARTIAL HEPATECTOMY OF RATS. M. Silha (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 12: 389-90(Oct. 1963).

Experiments conducted on white rats indicated that in the blood serum of rats subjected to hepatectomy a factor was present that stimulated mitosis. (OTS)

11858 CONTRIBUTION TO THE PROBLEM OF SENSITIVITY TO RADIATION OF BACTERIUM E. COLI DURING ITS GROWTH CYCLE. M. Vizdalova (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 12: 391-2(Oct. 1963).

Bacterium Escherichia coli B. was studied at room temperature and -72°C. The effect of the amount of oxygen present depends not only on its concentration, but also on the physiological factors of the irradiated cells. (TCO)

11859 PARTIAL PRESSURE OF OXYGEN AND SENSITIVITY OF MAMMALS TO IRRADIATION. A. Vacek and E. Davidova (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 12: 392-3(Oct. 1963).

Experiments with mice indicated that an increase in the partial pressure of oxygen in atmosphere increases the oxygen level in tissues, and thereby increases the metabolic activity and the diffusion of oxygen into the cells; increased sensitivity to irradiation results. (OTS)

11860 CORRELATION BETWEEN RELATIVE CONTENTS OF SULPHOHYDRIDE AND BISULPHITE GROUPS AND THE SENSITIVITY TO RADIATION OF THE CELLS OF MAMMALS. Yori Ueno (Kyoto Univ. and Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Cesk. Fysiol., 12: 393(Oct. 1963).

Experiments on mice indicated that SH- groups may protect living organisms from radiation effects. (OTS)

11861 PROTECTIVE EFFECT OF CYSTEAMINE AGAINST X RAYS APPLIED LOCALLY TO GUINEA PIG SKIN. A. Maggiora (Clinique Universitaire de Dermatologie, Geneva). Dermatologica, 127: 317-20(1963). (In French)

The protective action of cysteamine against local application of x rays to the skin of guinea pigs was investigated. The temporary epilation and acanthosis tests were used. For the epilation test, both sides of the animal were shaven and a 3-cm^2 area on one side was exposed to an 800 r dose of 50 kv x rays for 2 hours 32 minutes, which was followed by an intraperitoneal injection of 40 mg of cysteamine base, and, 5 minutes later, by identical x ray exposure of the other side. Results showed that only when cysteamine was injected before irradiation did it prevent temporary epilation, which always occurred in animals receiving 800 r and no medication. For the second test, the same procedure was followed, but radiation consisted in 1600 r given for 5 hours. When skin excision took place 27 days postirradiation, acanthosis was found to be far less pronounced on the protected side, this being a further demonstration of the protective action of cysteamine against x rays. Acanthosis, as measured by thickness of the epidermis, was about 50% greater in the animals injected with cysteamine after, as compared with before, irradiation. (BBB)

11862 CONTAMINATION OF HUMAN ORGANISM WITH RADIOACTIVE ISOTOPES. II. EFFECT OF COMPLEX-FORMING COMPOUNDS ON THE ACCELERATED EXCRETION OF THE ISOTOPES FROM THE SYSTEM. Jan Wozniak. Farm. Polska, 19: 403-6(Oct. 25, 1963).

The chemical composition (non-toxic), reactivity (must not absorb calcium from blood), structural formulation (to form stable and water soluble complex with radioactive toxin), and biological (not itself be subject to metabolism, be able to penetrate to foci of poison, and be able to prevent poison absorption through intestinal tract and processes involved in tissue damage) requirements of a substance to constitute an effective drug for the prevention and treatment of radioactive poisoning are discussed as pointers for research on their discovery or synthesis. (OTS)

11863 ANTIBIOTIC PROPHYLAXIS IN RADIUM THERAPY OF UTERINE CERVICAL CARCINOMA. H. Gutensohn and D. Buttenberg (Universitäts-Frauenklinik, Heidelberg). Geburtsh. Frauenheilk., 23: 832(Sept. 1963). (In German)

Comparison was made of the untoward reactions to radiotherapy of cervical cancer in the preantibiotic (1936-1948) and antibiotic (1949-1956) eras. This survey showed that febrile reactions to radiation were more than twice as frequent in the early period (28.8% compared with 13.5%). In spite of this reduction in febrile responses, apparently by more prevalent use of antibiotics, the cure rate was only slightly lower in the early period (27.1%) than in the late period (36.0%). The use of antibiotics along with Ra implantation is discussed. (BBB)

11864 OXYGEN EFFECT IN CLINICAL RADIOTHERAPY — FUNDAMENTAL CONSIDERATIONS IN RESPECT TO CLINICAL TRIALS. H. A. S. van den Brenk (Cancer Inst. Board, Melbourne). J. Coll. Radiol. Australasia, 6: 116-21(Dec. 1962).

Theoretical considerations, as well as experimental and clinical aspects, forming the basis and rationale of the newly developed high-pressure oxygen radiotherapy techniques, are discussed. Improvement of the ratio of radiosensitivity between tumors and normal tissues, with respect to oxygen-enhanced radiosensitivity can be obtained either by anoxemic conditions which favorably lowers O_2 tension in normal tissues, or by barotherapy as described. Various other aspects of this new technique, such as fractionation of dose, dosimetry, and selection of patients, are also discussed. (BBB)

11865 INFLUENCE OF AERATION DURING GAMMA IRRADIATION OF SCREW-WORM PUPAE. A. H. Baumhover (Dept. of Agriculture, Kerrville, Tex.). J. Econ. Entomol., 56: 628-31(Oct. 1963).

Development of the sterile-male technique has been used for control or eradication of the screw-worm fly (Cochliomyia hominivorax). Since quality-control checks in previous studies showed a variable response to the standard dosage of x rays, based on egg production by irradiated females, studies on the influence of aeration on dosage required to sterilize the female screw-worm fly were conducted. The primary influence was found to be availability of oxygen during irradiation. When pupae were irradiated in a carbon dioxide atmosphere, a dosage of 11,100 r was required to sterilize the females, compared with only 5500 to 6200 r required in oxygen and air (forced ventilation). Anoxia induced by consumption of oxygen by the pupae produced radiation-protection effects that were intensified by delay prior to irradiation and/or increased rate of oxygen uptake as pupae advanced in age. In practical tests, a canister made of ⅛-in. mesh aluminum screen provided sufficient diffusion of air to standardize the dosage safely at 6900 r, with up to 30-min delay prior to treatment for pupae 5 days of age or older. This dosage reduces by 50% that required under max conditions of anoxia encountered in production when a closed canister is used. Respiration studies for oxygen consumption vs age yielded the U-shaped

curve typical of that for other insects. Consumption of oxygen was 270 μl/g/hr for 5-day-old, 395 for 6-day-old, and 600 for 7-day-old pupae. These data explain the increase in radiation protection with age of pupae when ventilation is not provided. The max required dosage of 13,900 r encountered with the closed canister, compared with only 11,100 r with carbon dioxide, perhaps can be accounted for by a lag in reduction of oxygen in the cells of the older pupae. When pupae pretreated for 1 hr with carbon dioxide were given 11,100 r, average egg production was 0.86 compared with 0.03 with no pretreatment. The results of these tests demonstrate the need for adequate aeration prior to and during irradiation of screw-worm pupae. Without such control, it is impossible to standardize the dosage at the minimum level. Although results of recent tests fail to show differences in longevity of adults treated as pupae at 5600 r and 11,200 r, standardizing the dosage at the minimum level would greatly reduce the cost of the mass-sterilization facility. (BBB)

11866 ANTIRADIATION COMPOUNDS. IV. TRITHIOCARBONATES OF β-MERCAPTOETHYLGUANIDINES. William O. Foye, James Mickles, Ronald N. Duvall, and James R. Marshall (Massachusetts Coll. of Pharmacy, Boston). J. Med. Chem., 6: 509-12(Sept. 1963).

Evidence for the trithiocarbonate structure for the trithiocarbonate zwitterion of MEA is presented. Reaction of carbon disulfide with an aqueous solution of MEG, prepared from the alkaline rearrangement of 2-(2-aminoethyl)2-thiopseudourea dihydrobromide (AET), gave immediate precipitation of an insoluble yellow adduct. The product is most likely the trithiocarbonate zwitterion, as was found from the corresponding reactions with MEA and 2-diethylaminoethanethiol. However, since a dithiocarbamate or trithiocarbonate structure, both theoretically possible from this reaction, give the same elemental analysis, it was necessary to distinguish between the possible structures. Examination of the infrared absorption spectra of the MEG adduct showed definite trithiocarbonate absorption at 1038 cm^{-1}. The corresponding N,N,N'-trimethyl derivative of MEG, where dithiocarbamate formation would be less likely, also showed this absorption at 1026 cm^{-1}. The trithiocarbonate zwitterion of MEA showed this peak at 1018 cm^{-1}, and the carbon disulfide adduct of 2-miethylaminoethanethiol, which can be only a trithiocarbonate, absorbed at 1032 cm^{-1}. Furthermore, no absorption near 2550 cm^{-1}, due to a mercapto group, was evident with any of these compounds. Evidence from comparison of the ultraviolet absorption spectra of dithiocarbamates and trithiocarbonates also favored a trithiocarbonate structure. Tests for the ability of some of these compounds to protect mice against a lethal dose of x irradiation (800 r) were carried out. The trithiocarbonate of MEG gave good protection, comparable to that from MEG itself, in the dose range of 350–750 mg/kg. The trithiocarbonates of the N-amino derivative (N'-amino-2-guanidinoethyltrithiocarbonate zwitterion) and the N-methyl derivative also gave good protection, as well as did the trithiocarbonate of 3-mercaptopropylguanidine (MPG). The trithiocarbonates of the dicyclohexyl and imidazole derivatives gave only slight protection, whereas the trithiocarbonate of the trimethyl derivate gave no protection. The hydrobromide of dicyclohexyl MEG also gave no protection, but the latter 2 compounds were too toxic for appreciable doses to be employed (doses of less than 50 mg/kg were used). It appears, therefore, that 2 or 3 alkyl groups on the the guanidine nitrogens seriously diminish or remove radioprotective ability. One of the N,S-diacyl derivatives, the dioctanoyl, gave fair protection in the 150–350 mg/kg dose range. In addition, more detailed data for the protective ability of MEG trithiocarbonate (GET) after 800 and 900 r in mice are presented. (TCO)

11867 SECONDARY DISEASE IN RAT RADIATION CHIMERAS. H. Balner, M. J. de Vries, and D. W. van Bekkum (Radiobiological Inst., TNO, Rijswijk, Netherlands). J. Natl. Cancer Inst., 32: 419-59(Feb. 1964).

Rats were treated with homologous bone marrow following nearly lethal and lethal x irradiation. About 60 percent of the animals survived beyond the 4th week. In the rat-strain combination used, secondary disease developed during the 2d and 3d month in about 30 percent of the survivors, with emaciation and skin lesions as the principal symptoms. Surprisingly, colitis and diarrhea, prominent and consistent symptoms of secondary disease in the other species so far investigated, were never found, even in fatal secondary disease of the rat. There was no evidence of hemolytic anemia. The administration of homologous lymphoid cells provoked a faster, somewhat modified secondary syndrome with much higher mortality. In these rats, histologic lesions of the intestinal mucosa were found, but no colitis or diarrhea. Homologous bone marrow was also administered after median lethal radiation doses, which resulted in a temporarily functioning graft. A detrimental effect of such grafts, as described for certain mouse-strain combinations, was not found. (auth)

11868 RADIORESISTANCE OF PHYTOHEMAGGLUTININ-TREATED NORMAL AND LEUKEMIC LYMPHOCYTES. Robert Schrek and Stefan Stefani (Veterans Administration Hospital, Hines, Ill.). J. Natl. Cancer Inst., 32: 507-21 (Feb. 1964).

The effects of phytohemagglutinin (PHA) and x rays on suspensions of lymphocytes from normal human blood incubated in small test tubes for 6 days at 37°C were studied. Viable cell counts of untreated control suspensions showed that 63 percent of the lymphocytes survived incubation. Incubation of purified suspensions of lymphocytes with PHA resulted in enlargement of many lymphocytes, formation of some lymphoblastoid cells, and a few mitotic divisions. Irradiation of blood cell suspensions killed many lymphocytes, so that only 10 percent survived 6 days after a dose of 75 r 5 percent after 150 r. PHA-treated suspensions were irradiated with 75 to 2400 r. Many lymphocytes and transformed lymphocytes survived irradiation even with a dose of 1200 and 2400 r. It was concluded that addition of PHA protected lymphocytes against the cytotoxic effects of irradiation. Radioprotection of lymphocytes was observed whether the PHA was added at any time from 4 days before to 2 days after irradiation with 300 r. Blood lymphocytes from 3 of 6 patients with chronic lymphocytic leukemia showed little or no radioprotection with PHA. The morphologic reaction of lymphocytes from leukemic patients was usually less than that observed with normal lymphocytes. One of the 6 patients with chronic lymphocytic leukemia had blood lymphocytes resistant to x irradiation with 2400 r even without PHA. (auth)

11869 RADIATION DAMAGE TO ALBUMEN [ALBUMIN] AND SERUM BY THERMAL NEUTRONS AND GAMMA RAYS. ALLYLISOTHIOCYANATE, A RADIOPROTECTIVE AGENT. A. Heyndrickx and M. Avermaete (Université, Ghent). J. Pharm. Belg., 14: 309-20(Sept.-Oct. 1960).

The levels of sulfhydryl (-SH) and disulfide (-S-S-) groups in serum albumin under thermal neutron and γ irradiation were measured in the presence of the protective agents, cysteine, cystine, cysteinamine, cystamine, and

allylisothiocyanate. The formation of complexes and degradation compounds was also investigated by the polarographic technique. Using this technique it was demonstrated that complex formation occurs between sulfhydryl and disulfide groups reacting under the influence of neutrons and γ rays. On adding the radioprotective agents cysteine, cystine, cysteamine, or cystamine to albumin or serum it was noted that a precipitate also formed before irradiation had taken place. This was not the case if allylisothiocyanate was used. It was shown that radiation damage to the -SH and -S-S- system is not restricted to an oxidation or a breakdown of the -SH and -S-S- compounds alone. With albumin in an air-free medium it was shown that not only the -S-S- but also the -SH content increased after irradiation. With serum it was demonstrated that only the -S-S- content increased and not that of -SH. Results obtained with allylisothiocyanate followed the same pattern. Only the complex formed between allylisothiocyanate and albumin or serum gave titrable -SH or -S-S- compounds, not the agent by itself. In experiments with aerated solutions an increased amount of -S-S- was noted when serum was irradiated in the presence of cystine or cystamine; with allylisothiocyanate a lesser amount was formed. It was concluded that allylisothiocyanate is a better radioprotective agent for albumin and serum than cysteine, cystine, cysteamine, and cystamine. (BBB)

11870 THERAPY OF INTESTINAL SYMPTOMS IN THE FIELD OF RADIATION SICKNESS. K. Fochem (Universität-Frauenklinik, Vienna). Med. Klin. (Munich), 58: 258-9(Feb. 15, 1963). (In German)

As a result of x-radiation treatment for various diseases, such as gynecological carcinomas, ~11.8% of treated patients develop intestinal symptoms of radiation sickness. These symptoms include diarrhea, tenesmus, nausea, epithelial desquamation, and chronic enteritis and colitis. A total of 117 patients with these symptoms was given an oral preparation consisting of carob meal, with the addition of ~15% starch, 5% cacao, 2.5% mineral salts, 21% lignin and hemicellulose, 4% cellulose, 1% pectin, 4% protein, 1.5% fat, 47.5% soluble carbohydrates, and 3.5% water. These constituents favor gel formation and water retention within the intestine, resulting in reduction of motility and tenesmus. The intestinal flora and pH tend to revert to normal, and the acidotic environment is neutralized. Of the treated patients 98 responded favorably, while in 19 the results were equivocal or absent. The dose was 10 g given 3 times per day. At this dosage level it was unnecessary to interrupt the radiation treatment and the preparation remained palatable. In some patients the effect decreased after prolonged administration of the preparation, but a renewed full effect was obtained when treatment was interrupted for one week. The preparation is given only on appearance of symptoms and not prophylactically. There are practically no contraindications. In cases of intestinal stenosis or ulcers extension of the intestinal wall by accumulation of feces should be carefully controlled to avoid perforation. (BBB)

11871 EXPERIMENTAL DATA ON INCREASING RESISTANCE OF RATS TO RADIATION SICKNESS IN PREVIOUS INTRODUCTION OF TETRACYCLINES. A. M. Dumova and O. O. Chirkova. Med. Radiol., 8: No. 12, 50-5(Dec. 1963). (In Russian)

The oral introduction of tetracycline antibiotics to albino rats, the daily dose being 300 mg/kg, during 15–18 days previous to x irradiation afforded the evidence of a higher percentage of survival and life expectation of animals in the course of radiation sickness. Such increase of resistance of animals is recorded even when the animals are exposed 3 or 5 days after the introduction of antibiotics was completed. Bacteriologic investigations did not reveal any quantitative difference in the microflora of rats, irrespective of the fact whether or not antibiotics had been administered to rats previous to irradiation. On the basis of the data presented it was presumed that preliminary introduction of tetracycline antibiotics enhances protective mechanisms of the organism in radiation sickness regardless of the antibacterial properties of antibiotics. (auth)

11872 ON THE POSSIBILITY OF OBTAINING IMMUNE SERA ALLEVIATING THE COURSE OF RADIATION SICKNESS IN EXPERIMENTAL ANIMALS. V. I. Fofanov and A. T. Kravchenko. Med. Radiol., 8: No. 12, 55-9(Dec. 1963). (In Russian)

Studies were made on the possibility of sorption by aluminum hydroxide of specific proteins occurring in the serum of irradiated albino rats to obtain preparations for subsequent immunization of animals. Specific sera, resulting from the triple immunization of albino rats with the above preparations, alleviated the course of radiation sickness in test animals. The data so far obtained is considered to be tentative. (P.C.H.)

11873 RADIATION-INDUCED GIANT CELLS. THE EFFECT OF HALOGENATED THYMIDINE ANALOGUES AND AET. M. Klímek and M. Vlašínová (Inst. of Biophysics, Brno). Neoplasma, 10: 585-91(1963).

The effect of the radiosensitizers 5-bromdeoxyuridine, 5-iododeoxyuridine, and of the protective substance aminoethylisothiouronium on the development of giant cells in tissue culture was studied in quantitative conditions. Both the thymidine analogues, when added to the culture medium, cause a 50 per cent increase in the size of cultured cells. The same increase in size was observed in cells cultured with these analogoues for 24 and 48 hours. None of the above analogues exhibits a potentiating or a summation effect on the increase in cell size following irradiation with a dose of 1200 r, irrespective of incubation time. AET appears effective, influencing the development of giant cells following irradiation with doses ranging between 1200 and 3000 r. The irradiated cells reach a smaller size following irradiation if AET is present in the culture flask in the time of irradiation. (auth)

11874 SENSITIZATION OF PURINE-STARVED BACTERIA TO X RAYS. Henry S. Kaplan and F. L. Howsden (Stanford Univ., Palo Alto, Calif.). Proc. Natl. Acad. Sci. U. S., 51: 181-8(Feb. 1964).

Purine-requiring strains of E. coli grown on deficient levels of natural purines develop a 3-fold increase in sensitivity to the lethal effects of x rays. There is no concomitant change in uv sensitivity. Exponential growth of the purine-restricted cultures ceases prematurely but is otherwise normal, and viability remains unimpaired for several hours thereafter. The transition from the normal to the x-ray-sensitized state is an all-or-none phenomenon which follows exponential kinetics, with a half-time of 16–18 min. Cells begin to exhibit sensitization almost immediately in log-phase cultures, and after a minimal latent period of 1 hour in lag-phase. The sensitized state is completely reversible by purine supplementation. Sensitization and its reversal both appear to antedate cell replication. It is postulated that purine exhaustion may arrest the replication of new DNA strands after strand separation has occurred, producing partly denatured DNA molecules of high intrinsic radiosensitivity. (auth)

11875 STUDIES ON THE GROWTH-INHIBITING AND RADIOPROTECTIVE EFFECT OF CYSTAMINE, CYSTEAMINE, AND AET ON MAMMALIAN CELLS IN TISSUE CULTURE. Per Eker and Alexander Pihl (Norsk Hydro's Inst. for Cancer Research, Oslo). Radiation Res., 21: 165-79(Feb. 1964).

The growth-inhibiting and radioprotective effect of cystamine, cysteamine, and AET was studied in tissue culture of strain L mouse fibroblasts. When present in the growth medium during the 4-day test period, cystamine and cysteamine in concentrations above 0.9×10^{-4} M and 2×10^{-4} M, respectively, inhibited growth in monolayers. AET inhibited growth in concentrations exceeding 7×10^{-4} M. When the cells were suspended in saline and exposed to the sulfur compounds for 60 minutes only, concentrations of 2×10^{-3} M did not inhibit the subsequent growth in monolayers or in suspension culture. In the protection experiments the cells were suspended in Earle's salt solution and irradiated with x rays after preincubation with the test substances for 25 minutes. The subsequent growth in suspension culture was measured each 24 hours for 4 days. With cystamine and cysteamine in concentrations up to 2×10^{-3} M, no protection was found. With 2×10^{-3} M AET significant protection was obtained against the growth-inhibiting effect of 500 r of x rays. Sulfhydryl group titrations demonstrated that the mercaptoethylguanidine formed from AET was stable during the preincubation and exposure. Hence, the protective effect of AET cannot be attributed to oxygen depletion of the solution. Data are presented indicating that the failure of cysteamine to protect the L-cells is not due to lack of cellular uptake or to a rapid oxidation of the thiol to the inactive disulfide. The results indicate that different cell types may respond differently to the growth-inhibiting and radioprotective effect of the sulfur-containing agents. (auth)

11876 THE RELATIONSHIP OF SULFHYDRYL AND DISULFIDE CONSTITUENTS OF BACILLUS CEREUS TO RADIORESISTANCE. K. F. Bott and D. G. Lundgren (Syracuse Univ., N. Y.). Radiation Res., 21: 195-211 (Feb. 1964).

Sulfhydryl (SH) and disulfide (SS) levels in vegetative cells and spores of Bacillus cereus were studied in attempts to explain the biochemical basis for increased radioresistance of mature spores. Insight into this mechanism was facilitated by the use of an organic sulfur-requiring auxotrophic mutant. The determination of SH and SS was carried out on intact organisms polarographically by estimation of unreacted MeHgI, a reagent specific for SH groups. This reagent was made accessible to cells by treating them for 24 hours in the presence of 8 M urea. Results of various analyses of the wild-type strains agreed with published findings of Vinter, namely, that radioresistance increased with progressive spore maturity, and that spores had extremely low, or no, SH content. Mutant spores did not reflect a progressive radioresistance with maturation. In addition, it was noted that, when the mutant was grown on three different levels of cystine or cysteine, spores with greatest radioresistance were formed on highest amino acid concentration. However, this work failed to establish a direct relationship between disulfide content and radioresistance similar to that predicted by Vinter. Instead it was found that an increased SS/SH ratio accompanied the development of radioresistance in any cell sample. (auth)

11877 QUANTITATIVE STUDIES ON THE RADIATION PATHOLOGY OF THE BONE MARROW OF SMALL LABORATORY ANIMALS. II. MARROW RESPONSE TO WHOLE-BODY X-IRRADIATION IN RODENTS OF DIFFERENT LD_{50}. Frederic C. Ludwig and Henry I. Kohn (Univ. of California, San Francisco). Radiation Res., 21: 233-42(Feb. 1964).

In a series of experiments carried out during 1959–1963, the acute bone marrow response to x rays (LD_{50} dose) was investigated by direct counting techniques in strains of mice of different radiosensitivity (BALB/c, A/Crgl/2, C57BL, BCF_1) and in the Chinese hamster (Cricetulus griseus), which has the highest LD_{50} so far known in mammals. In all experiments, the animals were given a whole-body dose of 250-kvcp x rays (HVT = 1.5 mm Cu; absorbed dose rate about 45 rads/min; absorbed dose in soft tissue about 250 rads). The relatively uniform pattern of change in the nucleated cell count is consistent with the assumption that similar physiological mechanisms were at work in each animal but that genetic factors introduced quantitative differences in response. The principal differences were in the control counts, the percentage loss in control counts by four days after irradiation, and the percentage recovery by 18 days after irradiation. The Chinese hamster had the lowest control nucleated cell count and a recovery rate of this count that was no better than that of the mice. When the undifferentiated stem cell count was examined, however, it appeared that the hamster's recovery was remarkable; a marked hyperplasia of these cells was observed on days 4, 6, and 8 after exposure. Some recovery was observed 12 hours after exposure. It is suggested that this peculiar response of the stem cells of the hamster marrow is related to the high radioresistance of the species. (auth)

11878 MODIFICATION OF RADIOSENSITIVITY OF MICE BY INERT GASES AND NITROUS OXIDE. J. C. Evans, T. W. Roberts, and L. R. Orkin (Yeshiva Univ., New York). Radiation Res., 21: 243-55(Feb. 1964).

Nitrous oxide and xenon, in mixture with oxygen at elevated pressure, diminish radiation sensitivity to whole-body and segmental irradiation. This protection, although correlated with anesthetic effect of these agents, does not appear to be due to anoxia of vital tissues. (auth)

11879 MOVEMENT OF HORSE GAMMA GLOBULIN OUT OF AND ISOLOGOUS PROTEINS INTO PAPER IMPLANTS IN FOCALLY X-IRRADIATED RABBITS. William G. Glenn (USAF School of Aerospace Medicine, Brooks AFB, Tex.), Reuben L. Kahn, and George L. Anstadt. Radiation Res., 21: 267-84(Feb. 1964).

On rabbits unilaterally exposed to 930 to 1000 r of focal x-irradiation on two separate areas, 15 to 25 r was measured on the opposite side of the animals. When 274 μg of N_2 per 0.2 ml of a purified horse γ-globulin preparation was subcutaneously implanted for 48 hours in focally irradiated areas of rabbits, these areas showed decreased localization (increased protein escape) for the initial 24 hours after irradiation. Such antilocalizing activity of irradiation on subcutaneous areas decreased when measured at 7 and 14 days after exposure. In the study of the phenomena of localization and antilocalization as affected by irradiation, the quantitative results herein obtained by subcutaneous implants of heterologous protein parallels the results obtained by a toxin–antitoxin system. This finding indicates that the use of subcutaneous implants offers a method for more exacting quantitative studies of localizing phenomena. From the comparative absorption rates of heterologous and isologous proteins, this study suggests that, although irradiation can increase the permeability of an area, consideration must be given to the biological relationship between an injected foreign protein

and the host proteins. Proof that an increase in permeability is the predominant radiation effect should consider the differential innate ability of an animal to localize foreign substances. (auth)

11880 EFFECTS OF DIFFERENT IONIZING RADIATIONS ON HUMAN CELLS IN TISSUE CULTURE. IV. MODIFICATION OF RADIATION DAMAGE. G. W. Barendsen and H. M. D. Walter (Radiobiological Inst. of the Organization for Health Research TNO, Rijswijk, Netherlands). Radiation Res., 21: 314-29(Feb. 1964).

Modification by various treatments of radiation-induced damage in kidney cells of human origin was investigated with 250-kvp x rays and α particles from Po^{210}. The capacity for clone formation as a function of the radiation dose was found to be influenced significantly by the time interval between plating and irradiation, the temperature at which the cells were maintained before and after irradiation, fractionation of the dose, and the presence of oxygen, cysteamine, and glycerol. The modification of the response of the cells was shown to be much more important after irradiation with sparsely ionizing 250-kvp x radiation than with densely ionizing α-radiation from Po^{210}. An explanation of the differences between the effects of these radiations has been given on the basis of the differences in spatial distribution of the energy deposition. (auth)

11881 TOXICOLOGICAL STUDY OF 2-AMINOETHYL-ISOTHIOURONIUM HYDROBROMIDE (AET). USE OF AET AS A PROTECTOR AGAINST RADIOMIMETIC AGENTS. C. Gosse, R.-P. Dechambre, and C. Paoletti (Institut Gustave Roussy, Villejuif, France). Rev. Corps Sante Armees, 3: 79-91(Feb. 1962). (In French)

A chronic toxicity study indicated a higher survival ratio among AET-treated mice than in control animals with no relation between sex and mortality in either set; no difference in weight in males of the two series was observed over a 6-month period; no change in examined organs of animals sacrificed after 6 months was observed, nor any change in fecundity with respect to the control animals after correction was made for the survival factor. The effect of AET on the toxicity of bis(2-chloroethyl)-amine (HN2) to mice is: % surviving LD_{100} after treatment with AET intraperitoneally 10 min earlier, 10; LD_{75}, 60; LD_{50}, 90. The antiradiomimetic value of the drug is apparent, but the analogy of the action of HN2 to radiation is superficial. No difference in sensitivity between AET animals and control animals to metallic poisons such as $HgCl_2$ was noted. The use of AET or any other radioprotector in case of atomic attack appears illusory; oral administration may be less effective than the method employed; the duration of activity of the radioprotector is short; and the protector is effective only in doses approaching the toxic level, and man is particularly sensitive to AET. (BBB)

11882 REACTIVITY TO VEGETATIVE DRUGS IN THE ACUTE RADIATION SICKNESS. A. Danysz, H. Proniewski, K. Wisniewski, T. Zaczek, and B. Polocki (Medical Academy, Bialystok, Poland). Sb. Ved. Praci Lekar. Fak. Karlovy Univ. Hradci Kralove, 6: 11-18(1963).

Whole-body x irradiation with sublethal doses was given to dogs (400 r), cats (400 r), guinea pigs (450 r), and mice (180-200 r). The course of radiation illness was estimated on the basis of leukocyte count. During radiation sickness the changes in pharmacologic action and toxicity of various drugs affecting the autonomic nervous system were investigated. By tests on the reactivity of mouse intestine in situ it was shown that at the peak of acute radiation sickness the toxicity of parasympathicotonics (pilocarpine, prostigmine), especially of acetylcholine, sympathicolytics (Priscol), and ganglioplegics (nicotine) decreased. The toxicity of parasympathicolytic drugs (atropine) was higher. No changes of toxicity of sympathicotonics (adrenaline, iproniazid) were found, except for ephedrine, whose toxicity after irradiation significantly increased. Mouse intestinal motility tests showed a reduction 3-6 days postirradiation in the pharmacologic effects of parasympathicotonics (acetylcholine, prostigmine), especially of pilocarpine and ganglioplegics (nicotine, hexamethonium). At the same time the effects of sympathicotonic drugs (adrenaline, Sympatol) increased; on the contrary the monamine oxidase (MAO) inhibitor (iproniazid) showed a marked decrease in effect. With sympathicotonic drugs, pressor effects, changes of ECG, vasoconstrictive and mydriatic effects, and the contractive action on the nictitating membrane of cat were investigated. The pressor effects of adrenaline in dogs rose in the course of radiation sickness. No changes of pressor effects of noradrenaline and ephedrine were found, but the time of post-ephedrine hypertension was prolonged. In the acute stage of the illness, catecholamines evoked more significant changes in the ECG in dogs. During radiation sickness in cats, phasic changes in reactivity of the blood vessels in an isolated limb to catecholamines were observed: in the first phase, diminution; however, at the peak of the disease an increase in vasoconstrictory effects was seen. The action of iproniazid was insignificantly diminished. The mydriatic effect of catecholamines increased at the peak of radiation sickness. The reactivity of the nictitating membrane of cat did not change after smaller doses of adrenaline. In tests of parasympathicotonic drugs, the sensitivity of isolated guinea pig organs (intestine, uterus) to acetylcholine, pilocarpine, and prostigmine at the peak of radiation sickness was markedly diminished, but the sensitivity of intestinal smooth muscle to histamine remained unchanged. With parasympathicolytic drugs, an increase of mydriatic effect of atropine in irradiated mice was observed. Thus in most cases there were increased pharmacologic effects of direct-acting adrenergic drugs and decreased effects, but increased toxicity, of MAO inhibitors. The diminished pharmacologic effects and toxicity of parasympathicolytic drugs was also shown. The effects and toxicity of ganglioplegic drugs and toxicity of sympathicolytic drugs showed a marked decrease. The results indicate increased susceptibility of adrenergic receptors and diminished susceptibility of cholinergic receptors on the peak of radiation sickness. It is suggested that these changes may arise from the characteristic disturbances in functional state of the vegetative nervous system, and particularly on the neurohormonal basis. To verify this, catecholamine level in the adrenals and cholinesterase activity was determined. Catecholamine levels in the adrenals of irradiated mice varied phasically. In the first phase of radiation sickness (1-7 days) this level diminished to ~50% of the initial value. In the second phase it showed an increase of nearly 10 times. During radiation sickness a marked fall of acetylcholinesterase activity in the uterus, intestine, and brain of the guinea pigs was found. This supports the postulated parasympathicotonia at the peak of radiation sickness. The influence of increased acetylcholine level after prostigmine on the antiperistaltic action of adrenaline and on the toxicity of atropine and nicotine was investigated. Prostigmine in a dose of 0.75 mg/kg, causing an increase of the peristalsis in mice at the same time as the irradiation, evokes similar changes in reactivity in intestinal motility to adrenaline as irradiation. Prostigmine also causes a similar increase

of atropine toxicity in mice and a decrease in toxicity of nicotine, as irradiation does. A study was made of the influence of MAO inhibitors (iproniazid) on the course of acute radiation sickness, in an attempt to increase the tonus of sympathetic nervous system. It was found that use of iproniazid after irradiation in the dose of 10 mg/kg had no influence on the mortality rate but seemed to normalize to some degree the reactivity to autonomic drugs. These results with iproniazid seem to confirm the hypothesis of the insufficiency of the sympathetic nervous system in mice at the peak of acute sublethal radiation sickness. (BBB)

11883 CHANGES IN THE ACTIVITY OF THE HEART AFTER ADMINISTRATION OF EPINEPHRINE IN IRRADIATED ANIMALS. Vojtech Grossmann (Charles Univ., Königrätz, Czech.). Sb. Ved. Praci Lekar. Fak. Karlovy Univ. Hradci Kralove, 6: 19-22(1963). (In Russian)

The influence of epinephrine on pulse frequency and quality of the left ventricle heart beats in rabbits was studied. The effect of this drug in the controls and in rabbits irradiated by 1000 r was compared on the 3rd and 6th day after irradiation, and in the same manner its effect on the coronary flow was estimated. The results did not show any fundamental changes in the effect of epinephrine on rabbit heart during the first 6 days after irradiation. Only the contraction of the left ventricle was less influenced by epinephrine in the irradiated animals than in the controls, but the difference was statistically insignificant. (BBB)

11884 PRESSOR EFFECTS OF LEVARTERENOL AND EPINEPHRINE IN IRRADIATED RABBITS. Milan Dostal and Jan Zachvej (Charles Univ., Königrätz, Czech.). Sb. Ved. Praci Lekar. Fak. Karlovy Univ. Hradci Kralove, 6: 23-5(1963). (In Russian)

Rabbits after whole-body x irradiation with a dose 800 r were tested on the day of irradiation and on the first, second, third, and sixth day afterwards. No change was observed in the pressor effect of a single intravenous injection of infusion of levarterenol and epinephrine during barbital anesthesia. (BBB)

11885 CORTICOIDS IN THE TREATMENT OF RADIATION SICKNESS. Bernardo Dosoretz. Semana Med. (Buenos Aires), 121: 2013(Dec. 6, 1962). (In Spanish)

Exposure to therapeutic irradiation is frequently followed by various symptoms causing discomfort and distress to the patient. A group of 20 patients subjected to irradiation of the abdomen, thorax, or pelvis for treatment of cancer, and suffering from progressive nausea accompanied by vomiting, were given prednisolone (Deltacortril). The initial dose of 20 mg/day was reduced to 10 mg/day as the symptoms diminished, usually after 48 hours. Rarely was it found necessary to prolong the treatment beyond a week. Results were excellent in eight patients, in nine there was considerable improvement, and three received no benefit whatsoever. At the same time the general physical and mental state of all the patients improved. It was concluded that prednisolone is useful in the treatment of patients undergoing radiation therapy. (BBB)

11886 THE EFFECTS OF CHLORAMPHENICOL, STREPTOMYCIN, AND PENICILLIN ON THE INDUCTION OF MUTATIONS BY X-RAYS IN DROSOPHILA MELANOGASTER. A. M. Clark (Univ. of Tasmania, Australia). Z. Vererbungslehre, 94: 121-5(1963).

The injection of chloramphenicol, streptomycin, or penicillin into Drosophila males just before exposure to x irradiation caused a reduction in the yield of sex linked recessive lethal mutations. The effect appears to be primarily on spermatids and possibly spermatocytes. (auth)

11887 REPAIR AND DIFFERENTIAL RADIOSENSITIVITY IN DEVELOPING GERM CELLS OF DROSOPHILA MALES. F. H. Sobels (Universiteit, Leiden). p.179-197 of "Repair from Genetic Radiation Damage." New York, The Macmillan Co., 1963.

Pre-treatment of Drosophila germ cells with either chloramphenicol or ribonuclease was found to decrease the radioinduced frequencies of sex-linked lethals (X^{C2} y B chromosome) in stages showing peak sensitivity to x irradiation, corresponding to spermatids and late spermatocytes. In mature sperm these agents cause a significant increase of the mutation frequency. The results with spermatids suggest that inhibition of protein synthesis lowers the initial sensitivity to the induction of pre-mutational damage. Post-treatment with O_2, following radiation exposure fo 3000 r in N_2, lowers the mutation-frequency. It is thought that, under these conditions, O_2 acts by activating an inhibited repair system. After exposure to 1000 r in O_2, the effect of post-treatment with O_2 exactly equalled that of post-treatment with N_2. This finding is interpreted on the assumption that the biochemical system responsible for repair, is damaged to a greater extent by irradiation in O_2 than in N_2. The observation that after exposure of a ring-X chromosome there is a dose rate dependence in the presence of cyanide and that dose fractionation produces fewer mutations in spermatids than unfractionated radiation, support the idea that the repair system itself is liable to undergo radiation damage. Post-treatment with chloramphenicol produced an enhancement of the mutation frequency in two experiments; so did streptomycin. These findings are taken as an indication that protein synthesis is required for the repair process. In other experiments, however, post-treatment with chloramphenicol lowered the mutation frequency. It was concluded that the mutational response in Drosophila spermatids can be resolved into four components, which can be modified separately: initial radiosensitivity to the induction of pre-mutational damage, efficiency of the repair process, time of mutation fixation, radiation damage to the repair system. (P.C.H.)

Radiation Hazards and Protection

11888 THE IRRADIATION OF ORGANISMS BY ATMOSPHERIC DEPOSITS. M. Oncescu and A. Iorgulescu (Inst. of Atomic Physics, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 14: 769-73(1963). (In Rumanian)

From the relationships given in the literature on the calculation of the biological dose received by an organism because of the atmospheric radioactivity, the maximum levels permitted in this case are calculated. The maximum permissible levels depend on mean values of the preceding years and on the number of accidental irradiations. (tr-auth)

11889 ^{137}Cs AND ^{90}Sr IN SOME CULTIVATED PLANTS IN BERLIN-DAHLEM IN 1962. A. Kloke and K. Riebartsch (Biologische Bundesanstalt für Land-und Forstwirtschaft, Berlin-Dahlem). Atompraxis, 10: 51-2(Jan. 1964). (In German)

The determination of Cs^{137} and Sr^{90} in some cultivated plants, grown on soil in Berlin-Dahlem 1962 showed a specific activity four times higher than in the years

1958/59. A relationship between the surface condition and the extent of contamination was not found because of the many factors, such as exposition time, growth rate, and arrangement of the leaves, which contribute to the extent of contamination. Because of the radioactivity found in the investigated food plants it was concluded that the contents are above dangerous concentrations. (auth)

11890 FACTORS DETERMINING THE IMPORTANCE OF RADIONUCLIDES WHEN ASSESSING HAZARDS FROM INTERNAL RADIATION. J. Vennart (Radiological Protection Service, Belmont, Surrey, Eng.). Brit. J. Radiol., 37: 82-4(Feb. 1964).

The purpose of the symposium was to discuss the metabolism of those radionuclides of greatest importance in relation to radiological health and safety. Introductory remarks were directed to factors that determine the importance of certain radionuclides. Seven papers were presented; separate abstracts were prepared for each. (H.M.G.)

For abstracts of individual papers see: 11585, 11586, 11587, 11588, 11589, 11678, and 11891.

11891 SOME ASPECTS OF THE PREVENTION AND TREATMENT OF EXCESSIVE INTERNAL RADIOACTIVE CONTAMINATION. K. P. Duncan (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.). Brit. J. Radiol., 37: 120-3(Feb. 1964).

Some of the methods of reducing the radiation dose to critical organs following accidental intake of radioactive materials are reviewed. More detailed consideration is given to the place of isotope dilution methods with special reference to intakes of radioiodine and to the reduction of internal contamination by the administration of chelating agents with special reference to intakes of plutonium. (auth)

11892 THE PERIL AND THE POISON. Louis H. Nahum. Conn. Med., 27: 440-3(Aug. 1963).

Evidence relating to the hazards to the infant in utero from x-ray exposure, especially in the first trimester of pregnancy, is discussed. Two previous reports revealing increased incidence of cancer in children exposed to diagnostic x rays during gestation are analyzed and their present relevance evaluated. As a result of these studies, a direct comparison with radiation from normal background sources and fallout at comparable total doses is made. Attempts are made to answer the question of whether doses considerably larger than those average world-wide values can result from heavy fallout in certain areas because of unusual meteorologic conditions even for relatively small nuclear explosions, such as occurred in Troy-Albany area after a 40–50-kt low-altitude explosion in Nevada in 1953. (BBB)

11893 LIMITED AREA UROGRAPHIC FILMS TO REDUCE RADIATION EXPOSURE. Arjan D. Amar (Kaiser Foundation Hospital, Walnut Creek, Calif.). J. Urol., 89: 506-9(May 1963).

Techniques to reduce patient exposure during urographic procedures are described and illustrated with reference to several cases examined by these techniques. It is pointed out that urologic disease is often unilateral and that exposure of the unaffected side of the abdomen, and of its gonad, is frequently unnecessary and can be easily prevented by limiting radiation to the affected side. (BBB)

11894 WHERE NURSES ERR WHILE HANDLING RADIUM. Frances Ginsberg (New England Center Hospital, Boston). Mod. Hosp., 99: 138(Sept. 1962).

Abuses resulting from either lack of concern or ignorance of the use of Ra for treatment of uterine cancer are discussed. Active applicators are sometimes left soaking in a germicidal solution in an open, Monel metal basin. These materials may be placed in the center of an operating room supervisor's desk for hours, waiting to be used in a procedure. Active applicators may be left sitting in metal cups in a utility room, waiting to be cleaned, and nurses may carry active applicators in the pockets of their uniforms. Hospitals utilizing Ra usually keep a fixed inventory of 20 to 100 mg on hand, which must be stored in a thick leak-lined locked vault under the supervision of the chief of radiology. Only he, or trained x-ray technicians experienced in handling the material with lead-lined gloves, long forceps and body-shielding devices, should load the applicators and needles, submerge them in a germicidal solution, and see to their transportation to the operating room in a closed, portable, lead-lined carrier. Hospitals should have specific rules applying to patients who will receive Ra treatment. (BBB)

11895 DOSE TO THE POPULATION OF GREAT BRITAIN FROM THE MEDICAL USE OF IONIZING RADIATION: ITS MEASUREMENT AND PRACTICAL IMPLICATIONS. F. W. Spiers (Univ. of Leeds, Eng.). Radiography, 28: 401-6(Dec. 1962).

The compilation and evaluation of the report of the Adrian Committee (Radiological Hazards to Patients, London, Her Majesty's Stationery Office, 1960) are discussed. The report concluded that the measured dose levels did not show a need for major restrictions in radiologic practice and that the number and type of examinations or treatments must be dictated by the clinical needs of the patient. Among the evident implications of the report is the finding that on the basis of the range of doses measured for any one examination, the mean gonad dose is greatly affected by the proportion of high doses occurring in the sample measurements. The major part of the dose reduction, suggested as practicable by the Adrian Committee, could be achieved simply by better collimation and better direction of the x-ray beam. (BBB)

11896 PROTECTION AGAINST RADIATION IN THE DIAGNOSTIC X RAY DEPARTMENT. F. N. Gillwald (Welkom, Orange Free State, Union of South Africa). S. African Med. J., 36: 260-2(Apr. 7, 1962).

Six general principles to be observed in radiologic practice for reducing exposure to patients and personnel are proposed and discussed. They are: Quality of the beam; the quality of the beam should be improved to remove as much as possible of the useless and harmful soft or low-energy radiation which forms part of the spectrum emerging at the usual diagnostic ranges of kilovoltage; Use of the inverse square law; Use of cones and diaphragms; Use of lead, barium, and other radioabsorptive materials; Use of fast films and intensifying screens; Improvement in administration. (BBB)

11897 PRECAUTION IN THE USE OF IODINE-125 AS A RADIOACTIVE TRACER. Y. S. Bakhle, Wm. H. Prusoff, and J. F. McCrea (Yale Univ., New Haven). Science, 143: 799-800(Feb. 21, 1964).

The absorption of the low-energy radiation from iodine-125 under certain circumstances may be a serious disadvantage in its use as a radioisotopic tracer. (auth)

11898 UMWELTRADIOAKTIVITÄT UND STRAHLENBELASTUNG. BERICHT IV/62. (Environmental Radioactivity and Radiation Burden. 4th Quarterly Report, 62).

Bad Godesberg, Ger., Bundesminister fur Wissenschaftliche Forschung, 1962. 202p. 7.—DM.

The content of radioactive material in air, water, soil, and food and the radiation burden to the people of the Federal Republic of Germany are discussed. Monitoring the air and environment radiation, fallout and precipitation, surface water and waste water, drinking water, sea water, soil, and food chain is described. The content of radioactive material in the human body is discussed. Results are presented in tables and graphs. (M.C.G.)

11899 IMPORTANCE OF FREE DESOXYRIBONUCLEOTIDES IN RADIATION INJURIES. J. Soshka, L. Beneš, V. Drašil, Z. Karpfel, E. Paleček, and M. Skalka (Biophysics Inst., Brno). p.118-24 of "Pervichnye i Nachal'nye Protsessy Biologicheskogo Deistviya Radiatsii." Moscow, Publishing House of the Academy of Sciences, 1963.

Experiments, with suitable controls, were carried out in which irradiated mice were treated with desoxynucleotide derivatives; irradiated porpoise bone marrow has incubated with phosphate-P^{32} and formate-C^{14} and desoxynucleotide derivatives; chicken embryo extracts and fractions were tested; and autoradiographs of treated marrow smears were made. The results, the effects of desoxynucleotides on mitosis, the ability of these substances and embryo extracts to increase DNA synthesis suppressed by irradiation, and changes in desoxynucleotides and desoxynucleosides in the regenerating liver after irradiation, are thought to show that the radiation effects on processes leading to DNA synthesis are more important than on the polymerization process or on the macromolecular DNA structure. This is in agreement with results obtained by other workers, who showed that irradiation blocks enzyme reactions that result in synthesis of thymidilic acid. However, why these enzymes are inactivated differently from others is still not explained. Several possible explanations are suggested. (TTT)

Radiotherapy and Radiodiagnosis

11900 (AD-412857L) RESULTS OBTAINED TO DATE FROM A STUDY OF THE EFFECTS OF IONIZING IRRADIATION AND ITS EFFECT UPON FORMATION AND DEVELOPMENT OF THE HEALING WOUND. Final Technical Report, September 1, 1961–August 31, 1962. B. L. Reynolds (Texas. Univ., Dallas. Southwestern Medical School). Contract DA-49-193-MD-2193. 8p.

The healing of open skin wounds in rats was investigated in detail. Striated muscle, areolar connective tissue, certain endocrine organs, and the site of injury itself were investigated with respect to chemical changes during the process of healing. When exogenous total-body irradiation of 1200 to 1500 r was given at the optimum time during the recovery period, survival was increased from LD_{35} to LD_{45} at 15 days. By use of improved analytical techniques the behavior of steroid substances, aromatic acids, fatty acids, amino acids, and sialic acids were observed in each of the tissues. Examination of gas chromatograms indicated the partition of active substances, and served as a means of estimating the amount of administered irradiation, the possibility of natural survival, and the areas where therapy might be of assistance. (C.H.)

11901 TECHNICAL PROBLEMS OF VARIOUS DEEP-THERAPY IRRADIATION METHODS. I. Martos. Acta Chir. Acad. Sci. Hung., 3: VI-XIV(1962).

Several problems discussed in connection with conventional methods of x-ray treatment are the determination of the upper limits of high voltage during treatment, the degree of automation of the apparatus, and the optimum size of the units. The feasibility of increasing voltage with conventional equipment to produce harder radiation is discussed, and the design of a unit (THX-250) operating at 250-kv is described. The problems of patient immobilization and of dose calculation in moving-beam therapy are considered, and a new device for improving dose distribution is illustrated. Advantages of this apparatus may contribute to the elimination of the difficulties connected with moving-beam irradiation. Optimal characteristics of radioisotopes to be used in depth therapy are discussed. Shielding problems with isotope sources are discussed, and a unit devised in Hungary which incorporates a novel shielding system is described. (BBB)

11902 THE COBALT THERAPY UNIT GRAVICERT. L. Bozoky. Acta Chir. Acad. Sci. Hung., 3: XV-XX(1962).

The advantages of Co^{60} irradiation units over conventional x-ray devices are enumerated and the design of a Co^{60} unit (Gravicert) developed in Hungary is described. It is designed to provide maximum safety against radiation for the operating and maintenance staff. The dose rate is less than 0.1 mr/hr at the surface of the treatment head, so that the therapist should receive, even on the busiest days, only a fraction of the natural background radiation, averaging 0.36 mr/day. The treatment head is connected with the storage container in a wall by a steel tube through which the cylinder housing the source may slide from the wall into the treatment head and back into the wall. This tube that supports the treatment head is also covered by lead to protect the patients. The treatment head can easily be turned by hand around the tube. Thus the main characteristic of the Gravicert unit is the complete protection of the operating staff. Another feature of the Gravicert unit is that the transport of the source from the wall into the treatment head and back into the wall is performed by gravitation; the unit can be operated with complete safety without electricity. The working principle of the unit is described. The mobile patient-positioning device used with the unit is also described. Optical and mechanical means are provided for the selection of the source-skin distance. For optical centering, a source of light is mounted on each side of the treatment head. The 2 light beams along the main axis of the γ-ray beam, cross at a predetermined distance from the source. Two light patches appear on the patient which intersect exactly at the required distance. With a source of 1000 or 2000 C, 10^7–10^8 r can be administered in a few days. (TCO)

11903 COMPLICATIONS IN POSTOPERATIVE IRRADIATION OF MAMMARY CARCINOMA. OBSERVATIONS IN 585 PATIENTS TREATED AT RADIUMHEMMET 1955-1960. Folke Edsmyr and Rune Walstam (Karolinska Sjukhuset, Stockholm). Acta Radiol. (N.S.), 1: 397-406 (Dec. 1963).

Two previously described methods for the irradiation of parasternal and supraclavicular lymphnode metastases were used at Radiumhemmet, one based on the use of short-distance gamma beam therapy, the other utilizing 9 or 12 Mev electrons from a betatron. A report is given of the irradiation conditions and the clinical observations in 585 patients treated with these methods during the period 1955–1960. (auth)

11904 COMPUTER METHOD FOR TREATMENT PLANNING IN EXTERNAL RADIOTHERAPY. Hans

Halldén, Inger Ragnhult, and Bengt Roos (Universiteit, Göteborg and Chalmers Tekniska Högskola, Göteborg). Acta Radiol. (N.S.), 1: 407-16(Dec. 1963).

A method of automatic computation of dose distributions in multifield and moving field therapy is described. The isodose diagrams were transferred to numerical lattices in a Cartesian system and punched on paper tape. The treatment area was drawn in another Cartesian system in which the dose contributions from the different fields are added at a number of points. The calculation was carried out on a digital computer. The method is illustrated by examples, and corrections for different types of tissue are discussed. (auth)

11905 DETERMINATION OF INTEGRAL ABSORBED DOSE FROM EXPOSURE MEASUREMENTS. Carl Carlsson (Univ. of Lund, Sweden). Acta Radiol. (N.S.), 1: 433-58 (Dec. 1963).

Methods of evaluating integral doses administered in roentgen diagnostics and radiation therapy are analyzed. The calculations are performed by using either central-axis depth-dose data with a saturated contribution of scattered radiation, or roentgen radiation spectra, and performing necessary corrections for escape energy. The relation between exposure and the incident energy per unit area is calculated for the different spectra by means of energy absorption coefficients for air. Both methods give roughly the same results but disagree with certain published data. (auth)

11906 EVALUATION OF INTRA-ARTICULAR COLLOIDAL GOLD Au 198 IN THE TREATMENT OF PERSISTENT KNEE EFFUSIONS. Barbara M. Ansell, Ann Crook, J. R. Mallard, and E. G. L. Bywaters (Hammersmith Hospital, London). Ann. Rheumatic Diseases, 22: 435-9(Nov. 1963).

A new method, employing radiation, for inactivating inflamed synovial tissue was investigated. An attempt was made to produce radiation synovectomy, using the principle that colloidal Au^{198}, when injected into the knee joint, would behave like other particles and localize on the synovial membrane. A pilot study was undertaken to see if satisfactory diffusion throughout the knee joint and localization on the synovial membrane occurred. In four patients suffering from rheumatoid arthritis with persistent knee effusions, a tracer dose of 50μC Au^{198} was injected. At 1, 6, and 24 hours a scan of the knee was made, initially using a well-collimated scintillation counter with a ½ in. dia. sodium iodide crystal and later an automatic scanner. At 6 and 24 hours the regional lymph glands were also checked. Provided there was an effusion of moderate size, the introduction of colloidal Au^{198} into the knee joint was followed by its rapid diffusion throughout that cavity followed by localization on the synovial membrane. Thirty injections were given in 24 patients and all were followed for a minimum of one year. The range of dosage varied from 480 to 1000 r (mean 690 r). Clinical assessment of the state of the knees as previously described was made on the 3rd, 7th, and 21st day, and subsequently at 3 months and at 1 yr after the injection. The one-yr follow-up of 30 therapeutic injections showed a good result in 16, some effect in 7, and none in 7. In the 14 cases in which bilateral knee effusions were present, the treated knee tended to do better than the control. It is suggested that failure of this form of therapy may be due to the inability of the Au^{198} to penetrate far enough into very thickened synovial membrane. Yttrium-90, with its considerably greater penetration (over 3 mm) into the tissue, may be preferable and warrants further investigation. (BBB)

11907 ON THE SENSITIVITY OF MELANOMA IN HAMSTERS TO X IRRADIATION, COLD CYTOSTATICS, AND IMMUNOBIOLOGICAL INFLUENCES. T. Salamon and H. Storck (Universitäts-Klinik, Zurich). Arch Klin. Exptl. Dermatol., 216: 161-85(1963). (In German)

Groups of hamsters were inoculated with in vitro irradiated melanotic hamster melanoma tissue (doses of 600, 3000, 4500, 6000, 12,000, and 15,000 r). The control group received nonirradiated melanoma tissue. The increasing doses of radiation increasingly prolonged incubation for appearance of transplanted tumors. The 600-r dose only slightly delayed tumor growth; 3000-r irradiated tissue allowed tumor growth to become apparent on the 14th–16th day after inoculation, as compared with the control group in which tumors appeared already on the 10th day. There were no histologic differences found between the tumors of the control and experimental animals. In the four animals receiving 4500-r irradiated tissue, tumors developed on the 26th, 31st, 31st, and 54th day. None of the recipient animals developed tumors after inoculation with tissues irradiated with doses of 6000 r and higher. There was a relatively high occurrence of spontaneous deaths among the inoculated experimental animals, but the cause of this was not known. Cooling of melanotic tumor tissue to –28°C for up to 48 days inactivated the cells only reversibly. As a result of this freezing treatment the onset of tumor growth after inoculation of the frozen-stored tissue is delayed 4 to 19 days, depending on the length of cold exposure. Hamster melanoma seems to be sensitive to thio-TEPA (triethylenethiophosphoramide) and somewhat less sensitive to Cytoxan (cyclophosphoramide). Attempts were also made to irradiate melanomas internally by injection of 5 mc of I^{131} in hamsters bearing tumors, but it was found that I^{131} is not stored selectively in melanoma cells. Active or passive immunization against hamster melanoma could not be demonstrated experimentally. Thus, it is possible to transplant a hamster melanoma 2–3 times in succession, tumor growth occurring after each inoculation. The intraperitoneal injection of small amounts of serum taken from melanotic hamsters did not protect animals against transplanted melanoma. (BBB)

11908 CYTOLOGICAL PREDICTION OF RADIOSENSITIVITY IN CARCINOMA OF THE CERVIX. William Chanen (Royal Women's Hospital, Melbourne). Australian New Zealand J. Obstet. Gynaecol., 3: 14-20(Mar. 1963).

A study of sensitization response (SR) and radiation reaction (RR) values in radiation treatment of carcinoma of the cervix was conducted for evaluation of indices to select those patients most likely to benefit from postirradiational surgery. The presence of certain cells was regarded as an index of the sensitivity of the host to the invading cancer and was called SR. The SR value was expressed in terms of the number of these cells appearing in a differential count of 100 consecutive, nonmalignant epithelial cells. Evaluation of RR depends on changes appearing in the exfoliated benign cells in the vaginal smear after radiation therapy for cancer of the cervix. An index of response was expressed as the number per 100 non-malignant epithelial cells showing evidence of these radiation changes. The SR values did not provide a reliable prognostic index. In particular, no valid association could be demonstrated between SR value and the incidence of local residual growth or pelvic lymph node metastasis. RR studies revealed a significant correlation between RR value and the presence of local residual growth after previous radiotherapy. This finding can be used as an aid in selecting those patients who would best benefit from subsequent radical surgery. The draw-

backs involved in RR evaluation lie chiefly in the technical difficulties of the readings, in its limited use with small and superficial Stage I growths, and its failure to help detect the presence of nodal metastasis. Findings seriously question the clinical usefulness of the SR index. Furthermore, the SR value did not provide a reliable prediction of the subsequent RR value. The RR index, on the other hand, appeared to have definite prognostic implications. (BBB)

11909 DEPENDENCE OF CONVERSION RATIO ON THE DOSE OF RADIOIODINE IN FISH. W. S. Hoar and J. G. Eales (Univ. of British Columbia, Vancouver). Can. J. Zool., 41: 1061-7(Sept. 1963).

The effect of I^{131} dose on radioiodine metabolism in goldfish and other teleosts was investigated to ascertain whether so-called tracer doses, used to evaluate thyroid activity, injure thyroid tissue. Five to 400 μc of carrier-free radioiodide (NaI^{131}) was injected intraperitoneally in 0.05 ml of distilled water; 3, 4, or 8 days afterwards the plasma conversion ratios (CR) were determined. The CR represents the extent of turnover of I^{131} to plasma radiohormone and is considered a sensitive discriminatory test for thyroid activity. Goldfish at 20°C showed a correlation between the 4-day CR and dose of I^{131} over a dose range of 1.1 to 8.2 μc/g body mass. Other aspects of I^{131} metabolism did not correlate with dose. Chum salmon at 12°C also showed a correlation between CR and dose over a comparable range but goldfish (4°C), chub (4° and 20°C), steelhead trout (4°C), and sockeye salmon (4°C) showed no dependence of CR on I^{131} dose. Goldfish were unique among these species in possessing ruptured follicles and blood cells in the colloid. Ruptured follicles were also present in uninjected fish and there was no evidence to relate rupturing of follicles with dose-dependence of the CR. Hence, although all species were tested over the same dose range, only goldfish at 20° and chum at 12°C showed any correlation between CR and dose. Furthermore, the trend established in goldfish at 20° was absent at 4°C. The response of the thyroid to administered I^{131} by increasing the protein-bound iodine (PBI^{131}) level seems to be dependent on temperature, general metabolic state, and species. The difference in response between 2 species at the same temperature could be partly due to a difference in general activity of the gland between the two species. It could be due also to a difference in the topography of the scattered thyroid tissue. Where thyroid follicles are compactly arranged, the radiation flux per unit area of follicle will tend to be greater and presumably the harmful effects augmented. It is therefore emphasized that the effects of increasing doses of I^{131} on radioiodide metabolism are difficult to predict. They depend on many factors, prominent among which could be the topography of the thyroidal tissue and also the total amount of I^{131} accumulated by the follicles. It is concluded that doses of 1 μc/g may be effective in altering I^{131} metabolism, probably by increasing the output of radiohormone. (BBB)

11910 POSSIBILITIES OF INFLUENCING RADIOSENSITIVITY OF MALIGNANT TUMORS IN CLINICAL ACTINOTHERAPY. M. Konecny (Inst. for Oncology at the Regional Center of Public Health, Brno). Cesk. Fysiol., 12: 381(Oct. 1963).

The introduction of locally active agents into parts of the body that should be made more sensitive to radiation for the elimination of malignant tumors is discussed. (OTS)

11911 OVARIAN DAMAGE BY X-RADIATION FOR ARTHRITIS DEFORMANS OF THE PELVIS—NO ADDITIONAL RESPONSIBILITY TO INFORM THE PREVIOUSLY INFORMED PATIENT. R. Schmelcher (Bundesgerichtshof, Karlsruhe, Ger.). Deut. Med. Wochschr., 88: 1707-9 (Aug. 30, 1963). (In German)

The following facts were presented to the court. The plaintiff, born in 1915, had received deep x radiation during a period from 1951 to 1952 for deforming arthritis of the pelvis, administered by the defendant, a radiologist at a municipal hospital. Following the irradiation the menstrual periods of the plaintiff ceased. The arthritis worsened after a brief period of improvement. Plaintiff claimed that the radiation produced termination of ovarian function, produced castration, and may have exacerbated the arthritis. Plaintiff claimed damages for physical and personal injury. The court awarded damages. Both plaintiff and defendant appealed, and the former was awarded payment by the defendant, but this award was suspended by the appeals court after the defendant had made partial payment. The appeal court maintained that the plaintiff should have been informed of the danger of possible damage to ovarian function. However, it was not the responsibility of the defendant to inform the plaintiff of this danger before consent to treatment was given, provided that this information was otherwise available to the patient. Expert testimony indicated that x radiation may not have improved, and also may not have worsened the arthritis. (BBB)

11912 MEDICAL USE OF THE HIGH-ENERGY RADIATION. Kenji Takeshita and Seiichi Yoshimoto (Kyushu Univ., Fukuoka). Fukuoka Igaku Zasshi, 53: 75-82(Feb. 1962). (In Japanese)

Aspects of megavoltage radiotherapy discussed here include: utilization of higher tumor doses with reduction of skin damage, protection against radiation damage due to the reduction of radiation absorption by bone marrow and due to the decreased scattering to other critical organs, differences in RBE in the high-energy region, and effective exposure with the high-energy electron beam using the available range-energy relations. Measurements in appropriate phantoms are described and dose-rate and isodose distribution curves are shown for 200-kvp x rays, Cs^{137} and Co^{60} γ rays, 15 Mev Betatron x rays. For radiation therapy using these radiation qualities, the volume doses to a point at the various tissue depths of patients were calculated. Advantages of the various radiation sources in different therapy problems are discussed. (BBB)

11913 LOCALIZATION OF INTESTINAL BLEEDING USING A MINIATURE GEIGER COUNTER. B. McKibbin and B. W. Watson (Royal Infirmary, Sheffield, Eng.). Gut, 4: 82-7(Mar. 1963).

Attempts were made to develop a suitable detector capable of locating bleeding intestinal lesions following injection of red cells labeled with radioisotopes. Previously developed intraluminal counters have not been sufficiently sensitive to detect the slowly bleeding lesions of ten encountered clinically. The results are presented of experiments in dogs planned to elucidate some of the problems which might be expected to occur in the application of this technique to the human subject, and to formulate those conditions which would give the optimum chance of success. Radiophosphorus (P^{32}) was selected, on account of absence of γ rays whose penetrating power would mitigate against accurate localization. A maximum dose of 1 μC/kg was selected as providing a not unacceptable radiation hazard when applied to humans. Canine red cells were labeled, resuspended in saline, and then injected intravenously into the animal. Radioactivity of the intestine was assessed using a miniature halogen-quenched Geiger counter. The total activity injected into with simulated lesions ranged

from 18 to 40 μC, with an average of 23 μC. Loss of isotope from the circulation was less than 6% in 1 hour and less than 50% in 24 hours. In the animals operated on immediately after injection of the isotope the background in the gut was considerable and constant (±15%) throughout the length of the small intestine. Nevertheless it was found possible to locate as little as 1.5 ml of intraluminal blood accurately. In animals studied after 1–2 hours detection of 2 ml of blood was still possible but with less precision; the backgrounds were generally higher and there was more variation from place to place in the intestine (±20%). After 24 hr, detection was not possible; the backgrounds were still higher and the blood less active. It is concluded that the detection of extravasated red cells is feasible provided the investigation is carried out within an hour or two of injecting the isotope. This implies that the investigation must be employed at the time of an operation, the counter being introduced through an enterotomy. It is hoped to use a semi-conductor detector instead of the Geiger counter. A detailed procedure for clinical use of this technique is described. (BBB)

11914 RADIOGRAPHY WITH SCATTERED RADIATION. A. G. Richards (Univ. of Michigan, Ann Arbor). Health Phys., 10: 41-2(Feb. 1964).

Seven radiographs of the oral region of a manikin were produced simultaneously by lead-walled pinhole cameras. Scattered radiation, originating mainly in the tongue, was used to produce the radiographs. The tongue was irradiated by a beam of x rays directed vertically through the floor of the mouth. (auth)

11915 ANESTHESIA FOR BAROTHERAPY. N. M. Cass (Peter MacCallum Clinic, Melbourne). J. Coll. Radiol. Australasia, 6: 101-3(Dec. 1962).

An evaluation was made of various anesthetic techniques and agents employed in the newly developed high-pressure oxygen radiotherapeutic method. Results are reported for 334 courses of anesthesia given to patients prior to treatment with megavoltage x rays under high oxygen pressure. Reasons for anesthesia during barotherapy are discussed. The optimal anesthetic technique combines heavy premedication with pentobarbitone. Promethazine (25 mg) is given orally 4 hr before treatment. Two hours before treatment papaveretum and scopolamine are given hypodermically. On arrival in the treatment suite, patients are given pentobarbitone (Nembutal) intravenously. Since light hypnosis with barbiturates increases reflex response to pain, pethidine was given intravenously in doses of 50 to 150 mg. Four % cocaine in adrenaline (1 : 100,000 solution) is then applied to the nostrils, and the trachea and larynx sprayed with 4% lignocaine. In 334 anesthetic courses there were no deaths and minimal complications. Epileptiform convulsions occurred during three compressions. (BBB)

11916 THE USE OF RADIOACTIVE ISOTOPES IN HAEMATOLOGY. A. Elwis (City General Hospital, Sheffield, Eng.). J. Med. Lab. Technol., 19: 75-88(Apr. 1962).

Basic principles of radioactivity are outlined, pertinent terminology defined, and practical applications of isotopes in clinical diagnosis reviewed. The investigation of patients by radioisotopes is only advocated where an answer can not be found by more simple procedures, although little hazard is involved in tracer work. The doses of the radioisotopes given are extremely small and in general the half life of biologically important isotopes is short. (BBB)

11917 COBALT-60 IRRADIATION IN THE TREATMENT OF CARCINOMA OF THE PHARYNX. Frank S. Moody (Univ. of Alabama, Birmingham). Laryngoscope, 72: 1549-84(Nov. 1962).

Telecobalt irradiation techniques are extensively discussed, from the viewpoint of historical development, definition of terminology, advantages and disadvantages, tissue dose distribution, clinical effects in oral oncology, and measures for limitation of beam area. (BBB)

11918 THE DEFINING OF IRRADIATION FIELDS IN TELECURIE THERAPY WITH COBALT-60. F. Heinzel and F. Jensen. Med. Mundi, 9: 8-12(1963).

The efficacy of various measures on the course of the dose at the edge of the field in telecurie therapy with Co^{60} was determined. The size of the radiation source, the diaphragmatic arrangement, the scattering medium, and the design of the diaphragm (rectangular or focused) all have their effect on the penumbra in telecurie therapy with Co^{60}. Measuring results were in accordance with the expectations derived from simple geometric considerations on the basis of the inverse square law and the dimensions of the radiation source as well as the diaphragmatic geometry. (P.C.H.)

11919 THE ALPHA PARTICLE OR PROTON BEAM IN RADIOSURGERY OF THE PITUITARY GLAND FOR CUSHING'S DISEASE. John A. Linfoot, John H. Lawrence, James L. Born, and Cornelius A. Tobias (Univ. of California, Berkeley). New Engl. J. Med., 269: 597-601 (Sept. 19, 1963).

The use of high-speed protons for specific destruction of cranial lesions is reviewed. Applications of heavy particles in suppressing pituitary function and alleviating the symptoms and signs of Cushing's disease are discussed. The use of 900-Mev particles for this purpose in 2 cases is described. The results show that by the use of heavy particles, such as α particles and protons, it is possible teletherapeutically to deliver larger amounts of ionizing radiation than can be administered by x-ray or γ-ray sources. This radiation can be accurately localized to the pituitary gland and delivered with little scatter, thus reducing the danger to surrounding central-nervous-system structures; and a more favorable skin-depth dose relation and greater biologic effectiveness can be achieved. (BBB)

11920 RADIOSURGERY. Paul J. Friedman (Columbia-Presbyterian Medical Center, New York). New Engl. J. Med., 270: 109(Jan. 9, 1964).

The radioresistance of the pituitary gland is discussed in relation to the use of supervoltage x radiation, Co^{60} γ radiation, and fast-particle radiation for abolishing its endocrine activity. (BBB)

11921 EFFECT OF Sr^{90} IRRADIATION ON PTERYGIUM. Y. Kimura, T. Yamamoto, and M. Usui (Tottori Univ., Japan). Nippon Ganka Kiyo, 14: 116-18(Apr. 1963). (In Japanese)

Irradiation with Sr^{90} was given three to four days after the resection of pterygium in four cases of primary and two cases of recurrent pterygium. For irradiation a Sr^{90} applicator was used to give 200 rep at a time and a total of 1400 rep. A month later no recurrence of pterygium was observed nor side-effects caused by irradiation. (BBB)

11922 AN INSTRUMENT TO BISECT THE ANGLE AND REDUCE PATIENT IRRADIATION. Fred M. Medwedeff and William H. Knox (Vanderbilt Univ., Nashville). Oral Surg. Oral. Med. Oral Pathol., 16: 1049-56(Sept. 1963).

The described new design provides a device to be used with the short-cone, bisecting-the-angle procedure. In the long-cone or paralleling technique, the central ray is directed perpendicular to the long axis of the tooth and film, the film being placed vertically in the mouth parallel to

the long axis of the teeth being examined. The long-cone instrument consists of a collimating-aiming element joined by an arm to a film-holding device. The film is held parallel to the collimator surface, and the x-ray beam is directed at right angles to both. In the short-cone technique, the central ray is directed perpendicular to the bisector of the angle formed by the plane of the film and the long axis of the tooth. To adapt the instrument to the short-cone procedure, it was necessary to use two hinges: one to locate the film and the other to set the plane of the collimator parallel to the line that bisects the angle formed by the long axis of the tooth and the plane of the film. The two hinges must be on the same axis, so that rotation of the collimator will direct the central ray to the film. The instrument, described and illustrated in detail, is designed for use with standard sized film in the upper right and lower left premolar and molar areas, and a counterpart is used for the upper left and lower right regions. The instrument consists of the following parts: a collimator or aiming element, which reduces the beam to a ¾ by 1 in. rectangle; the arm, which attaches the collimator to the series of hinges; the shield, which holds and supports the film and eliminates most of the exit radiation transmitted through tissues and lead film backing; the hinge connector that is a stationary part of the instrument and reference plane for the adjustable angles; and two pins attached to the arm by a chain. The instrument and film are inserted in the mouth, a sawed-off cone is brought into complete contact with the collimator, and an exposure is made. Reduction of patient irradiation dose and diminution of cone scatter are demonstrated as a result of use of this device. It is concluded that this practical mouth-held instrument for the short-cone technique may be used for the purpose of collimating the x-ray beam to a rectangular size only slightly larger than film size, and that it affords radiation dose reduction, correct angulation, and accurate bisection of the angle. (BBB)

11923 PROTECTION: A "HELPING HAND." E. R. Hutchinson (Cardiff Radiotherapy Center, Wales). Radiography, 27: 242-5(Aug. 1961).

Manipulation of Ra sources in radiotherapy departments is discussed from the point of view of the hazards involved and available protective devices, especially remote-handling equipment. A so-called Helping Hand device, constructed in several models of various sizes and applications, is illustrated. Characteristics and advantages of the device are discussed. A table is provided of inverse-square calculations showing how the magnitude of dose varies, from the holding of a 25-mg tube of Ra in the bare fingers to the use of a 28-in. Helping Hand. (BBB)

11924 EXPERIENCE WITH COBALT BEAM UNIT GUT-CO-400-2. L. Brueckner, J. Cerny, and F. Beska (Oncological Inst., Paskov, Czechoslovakia). Radiol. Clin., 32: 142-51(1963).

Installation, characteristics, and application of the Soviet-supplied Co^{60} radiation unit are described, and early experience in establishing optical dosage, as well as radiation injuries resulting from its use, is discussed. One of its essential disadvantages, the low activity of the unit (optimum charge is 400 radium gram-equivalents), causes the need for excessively long periods of irradiation. At the beginning an error in the method of irradiation was made by setting the fields close to one another, thus risking overdosage. Results are described in 169 cancer patients subjected to: palliative therapy: 3000 to 5000 r focal dose during 14 to 21 days; and curative therapy: 5000 to 7200 r at the focus, over 4 to 8 weeks, the daily dose being 250 to 300 r per field with a daily focal dose of 200 to 220 r. Injurious effects of such Co^{60} irradiation were compared to those seen in other patients receiving conventional x-ray therapy. General symptoms in the sense of a postirradiation syndrome, even with high doses, did not reach the degree seen after x-ray therapy. Less alteration in the blood count occurred as compared with x rays. (TCO)

11925 TREATMENT PLANNING WITH 2 MV X-RAYS: SOME TECHNICAL ASPECTS OF DOSIMETRY AND BEAM DIRECTION. John Hale and A. Raventos (Univ. of Pennsylvania, Philadelphia). Radiol. Clin. N. Am., 1: 245-59 (Apr. 1963).

Problems of dosimetry and beam direction encountered in using a 2-Mev Van de Graaff unit are discussed. Techniques are examined for reducing errors that may occur when depth dose data, as published, are used for patient dosimetry. It was found practical to correct routinely for patient curvature with the tissue contour compensator method of Hall and Oliver. An aluminum compensating filter is used to correct irregular patient contours to an ~plane surface at right angles to the central ray of the treatment beam. Transit dose corrections for tissue inhomogeneity are made by comparison of doses measured in a phantom with calculated doses that neglect the tissue inhomogeneity error and construction of a table of standard correction factors for standard treatment plans. With a focal-chamber distance of 300 cm the ratio of transmitted dose to air dose was measured for several field sizes with cylindrical water absorbers of varying diameter. When the fractional transmitted dose was plotted against field size, the slope of the curve, 0.0751 cm^{-1}, is the transmission coefficient of the beam in water when the effect of scattered radiation has been eliminated. This transmission coefficient is called the zero area transmission coefficient. The new design gives a greater exposure rate but a lower half-value thickness (12.0 cm Cu) at 2 Mv. Clinical application of the transit dose method is described and examples of its use presented. The Du Sault system for the construction of standard summation isodose curves that are normalized to a predetermined source-to-target distance was extended to 2-Mev x-ray beams. Using basic isodose data, dose curves normalized to a target distance of 100 cm were constructed and a library of fixed field summation isodose distributions was calculated. Typical standard isodose distributions are shown and applications of the distribution to a particular patient illustrated. Treatment techniques using wedge filters were explored. Two treatment fields that have been shaped by wedge filters can be applied at 90° separation to produce an almost ideal dose distribution for small lesions restricted to one quadrant in the head or neck. By use of ionization chambers in a Pressdwood phantom, isodose curves were plotted for the 2-Mev beam with 2 Cu wedge filters, 7 and 11 cm wide. It was found that the calculated and experimental curves had very nearly the same slope but that the depth dose values disagreed by as much as 8%. Final isodose curves were made in which the calculated curve shapes and the experimental depth dose values were used. The use of fields shaped with wedge filters for the treatment of a lesion in the maxillary sinus is illustrated. Comparison with the summation isodose curves that would have been obtained if the wedge filters had not been used showed the improvement in dose homogeneity within the target volume and the reduction of dose outside the target volume that can be obtained with the wedge filter technique. The accurate control of beam direction is considered with regard to two factors: the point and the angle of entry of

the axis of the beam. A back-pointer developed for use with the Van de Graaff unit is shown. The pointer, located on the wall opposite the therapy unit, is raised or lowered until the reading on its vertical height scale corresponds to that on the treatment head. To ease the time demand on the Van de Graaff treatment facility, a treatment simulator, which is shown, is installed in another room. The beam-localizing accessories for the simulator, including back-pointer and pin and arc, are exactly the same and have the same position relative to the focal spot as those of the treatment unit, but the beam is provided by a 100-kv diagnostic tube. (BBB)

11926 A WAY AHEAD FOR THERAPEUTIC RADIOLOGY. Mortimer L. Mendelsohn (Univ. of Pennsylvania, Philadelphia). Radiol. Clin. N. Am., 1: 261-4(Apr. 1963).

The possibilities for major breakthroughs in radiotherapy techniques are discussed, and it is suggested that it is likely that these research efforts and an increasing knowledge of the biology of cancer will result in a succession of relatively small gains rather than single giant steps forward. In addition to new data on optimal dose, dose rate, fractionation, radiation quality, and other biologic factors, recent research has brought insight into the role of oxygen, radiomimetics and radiosensitizers, as well as new understanding of the underlying nature of cell sensitivity. However, advances have not dramatically changed the course of cancer therapy. It is suggested that perhaps the most direct approach to significant improvement in radiotherapy is not the search for heroic departures, but the steadfast attempt to achieve the best possible results with the tools currently available. A multidimensional analysis of optimal total and fractionated dose factors is presented. The multiple relations of dose, fractionation, and response are illustrated as analogous to a contour map, and the optimization problem reduces to finding the latitude and longitude of the highest peak on the map. Although this 3-dimensional model cannot represent realistically the problems of this operation, mathematics gives the facility to utilize 6 to 7 dimensions as easily as 2 to 3. Thus, dose, fractionation, ambient oxygen tension, and radiation quality can be considered as 4 variables of therapy; and the optimum response sought in 5-dimensional space. The difficulties of measuring appropriate responses to therapy, of adequately defining the therapeutic variables, and of collecting samples of adequate size to test the expected differences are all important ones. It is suggested that the analytical and clinical problems in a multiple variable analysis of radiation response are beyond the capacity of personnel or clinical material in any one therapy center. Comprehensive analyses would thus accrue from a large-scale attempt to pool data from many clinical centers. Statisticians supported by the processing capabilities of digital computers can provide the much needed analytical help. It remains the job of the therapist to collect the necessary data, and for this project to succeed, be willing to become part of a large-scale program. It is concluded that to discover how much of the power of radiotherapy has been left untapped, a grander design is now needed. (BBB)

11927 RADIATION THERAPY: TRENDS FROM ART TO SCIENCE. Richard H. Chamberlain (Univ. of Pennsylvania, Philadelphia). Radiol. Clin. N. Am., 1: 265-70 (Apr. 1963).

Development of radiotherapy techniques, evaluation of their effectiveness, and possible means of improving their effectiveness are discussed. Nontarget volume includes all other portions of the body that are included in the course of primary beam radiation or receive scattered radiation. This concept is idealized schematically. It is suggested that undue emphasis should not be placed on factors such as percentage depth dose, penumbra, skin sparing, forward scatter, and mass absorption coefficients, which individually and in themselves may obscure rather than clarify the total dosage pattern, which should be viewed in its entirety. No beam methods of radiotherapy, megavoltage or otherwise, give ideal patterns of absorbed radiation dosage, even with the most ingenious plans for technical administration. Megavoltage therapy gives more favorable patterns within and without the target volume. Various types of megavoltage sources are described and their characteristics briefly discussed. Improved techniques with internally applied radionuclides are also discussed. (BBB)

11928 RADIATION DISTRIBUTION AROUND DUMBBELL AND INDIAN CLUB RADIUM NEEDLES. Morris Hodara and Milton Friedman (Hospital for Joint Diseases, New York). Radiology, 82: 262-6(Feb. 1964).

The radiation distribution around 2 types of commercially available dumbbell needles and one type of Indian club needle was measued. The results show that overloading a radium needle at one end (Indian club) or both ends (dumbbell) increases its efficiency in several ways: it lengthens the cylinder of irradiated tissue out to the end of the active source; it improves the homogeneity of dose distribution on the surface of a cylinder around the source; and it flattens the isodose curves so that they are more nearly parallel to the axis of the radium needle. In a single-plane implant, the employment of Indian club or dumbbell needles improves the efficiency in the following ways: it eliminates the necessity of a crossing needle at the open end; it lengthens the volume of tissue being irradiated; it increases the homogeneity of dose distribution; it produces a sharper fall-off in dosage beyond the active ends of the needles, as compared with a crossed-end implant with standard needles. (P.C.H.)

11929 ENTRANCE AND EXIT ABSORBED DOSE CHARACTERISTICS FOR A 6-Mev X-RAY GENERATOR. E. Carl Chamberlain and Norman A. Baily (Univ. of California, Los Angeles). Radiology, 82: 267-71(Feb. 1964).

The absorbed dose under various conditions of non-electronic equilibrium was investigated for the bremsstrahlung produced by 6-Mev electrons incident on a thick gold transmission-type target. The absorbed dose was measured with a large field extrapolation chamber. Both entrance and exit dose rates were compared to those obtained at the peak for a series of entrance field sizes ranging from 4 to 625 cm^2 in area. Center-line depth-dose curves for a 10 × 10-cm entrance field obtained with the extrapolation chamber and with a thimble-type ionization chamber in a water phantom were compared. The absorbed dose at the entrance surface was less than 30% of the peak dose rate for all field sizes used. The exit dose rates for the same size fields exceeded skin dose by factors ranging from 7.9 to 1.2. The results show that isodose curves made from thimble chamber measurements in water phantoms are sufficiently accurate for clinical purposes. The exit absorbed dose rate, even for thick body sections and large entrance portals, is sufficiently high that consideration must be given to this factor in overall treatment planning. The absorbed dose at the skin for the entrance portal is low for all field sizes of practical interest, so that the usual limitations imposed by this quantity will not prevail for a beam of this quality. (auth)

11930 EXIT-SURFACE-DOSE CORRECTION FACTORS FOR X-RAYS OF 1.5 TO 4.0 mm. Cu HALF-VALUE LAYER. Jean-Marc Légaré (Queen Elizabeth Hospital, Montreal). Radiology, 82: 272-9(Feb. 1964).

The exit-surface dose correction factors for x rays of 1.5 to 4.0 mm Cu half value layer were measured and tabulated for total tissue thicknesses of 0, 5, 10, 15, 20, and 25 cm and for field sizes ranging from 4 × 4 to 15 × 15 cm, at 50-cm target-skin distance. The factors were then used to estimate the actual tissue exposure dose at the exit-tissue surface. They were also used to subdivide the total scattered radiation at a given depth into two quantitatively known forward and backward components. (auth)

11931 THE USE OF A SOFT DENTURE-BASE MATERIAL IN THE MANAGEMENT OF THE POST-RADIATION DENTURE PROBLEM. Melvin L. Griem, John E. Robinson, Jr., and George W. Barnhart (Univ. of Chicago). Radiology, 82: 320-1(Feb. 1964).

A technique is described for the prevention and treatment of sores after radiotherapy of the oral cavity. It was found that by introducing a soft denture liner between the methyl methacrylate dental base and the epithelium covering the alveolar ridges, the sore can be treated. The soft denture base is also used prophylactically in the post-treatment reconstruction of the dentures. (P.C.H.)

11932 AN AUXILIARY BEAM-DEFINING DEVICE FOR COBALT THERAPY. Simon Kramer, Walter G. Gunn, David Kusner, and Thomas Simpson (Jefferson Hospital, Philadelphia). Radiology, 82: 325-6(Feb. 1964).

An auxilary beam-defining device that attaches to the distal collimator end of a cobalt apparatus is described. The device permits a sharply margined beam to exit at right angles to the collimator end regardless of the position of the beam head. It employs movable lead bars that can be interlocked to provide a range from zero field to a 20 × 20 cm field at 80 cm SSD. It also provides a great degree of flexibility in beam shaping. Construction details are given. (P.C.H.)

11933 LIMITED VOLUME RADIATION THERAPY WITH THE ELECTRON BEAM. Norah duV. Tapley and Gilbert H. Fletcher (Univ. of Texas, Austin). Radiology, 82: 327-8(Feb. 1964).

The use of electron beams for radiotherapy is discussed. It was concluded that electron beams can be of particular value for lesions no deeper than 5 cm from the skin surface. (P.C.H.)

11934 INVESTIGATION OF THE POTENTIAL THERAPEUTIC APPLICATIONS OF FAST NEUTRONS FROM A LINEAR ELECTRON ACCELERATOR. J. J. Hazel, L. G. Stephens-Newsham, and H. Zwick (Royal Victoria Hospital, Montreal). Radiology, 82: 329-30(Feb. 1964).

An investigation was made on the production of fast neutrons from an 8.5 Mev electron accelerator. Studies were also made on different target materials and geometric arrangements for highest neutron flux, as well as of the problem of reducing the x-ray contamination. The various target materials investigated included U, Au, Be, and D_2O. Heavy water gave the best yield, and 10% higher than that of Be, and the yield increased with the volume of the target. Up to 2 liters were used for which the yield was 2.6×10^{10} neutrons per second. However, it is noted that at energies above 8 Mev there is considerable neutron production from heavier targets and this might complicate the use of such machines in radiotherapy, even though the dose rate is low. (P.C.H.)

11935 THE PROBLEM OF THE RELATIONSHIP OF RADIATION THERAPY OF NONMALIGNANT DISEASES TO THE INITIATION OF MALIGNANT TUMORS IN GYNECOLOGY. R. Kepp (Universitäts-Frauenklinik, Giessen, Ger.). Zentr. Gynaekol., 83: 1-5(Jan. 7, 1961). (In German)

The danger of initiating malignant tumors as a result of radiation treatment of nonmalignant ovarian or uterine disorders is important. In humans the latency period between irradiation and appearance of malignant tumors is ~10 to 12 years, but this period may be altered by hormonal influences. In one study the incidence of ovarian tumors was 1.54% at from 10 to 15 years after irradiation, and in another study, after Ra or x-ray therapy, the incidence of uterine carcinoma was 2%, with the average interval for carcinoma of the uterine cervix and body being 12.8 and 16.5 years, respectively. The results suggest that it is not the radiation as such, but a physiological predisposition, which is responsible for the development of malignant tumors. In patients treated for hemorrhagic disorders the incidence was only 0.94%, but it was 11.11% in patients treated for genital disorders. Increased rates of incidence of carcinoma of the body of the uterus or of mucosal hyperplasia may be related to uterine myomatosis or to uterine polyps. Beta radiation does not seem to have any greater ability to produce malignant tumors than does x radiation. In any case, treatment with ionizing radiation should not be undertaken lightly, and should be considered against other therapeutic measures, such as surgery. The danger of induction of a malignant tumor is always present, and the immediate hazards of an operation should be compared with the latent possibility of tumor formation later. A choice can be made only according to the particular clinical situation. (BBB)

11936 CHIRURGISCHE MASSNAHMEN ZUR ERGANZUNG DER STRAHLENTHERAPIE UND ZUR BEHANDLUNG VON STRAHLENFOLGEN IM GESICHTS-KIEFERBEREICH. (Surgical Procedures to Supplement Radiotherapy and for the Treatment of Radiation Sequelae in the Facial and Maxillary Field.) K. Schuchardt, ed. Stuttgart, Georg Thieme Verlag, 1962. 202p. 87 DM.

The plastic surgical repair of facial injuries resulting from radiotherapy is described and illustrated. (BBB)

11937 THE REDUCTION OF PATIENT DOSE BY DIAGNOSTIC RADIOLOGIC INSTRUMENTATION. Robert D. Moseley, Jr., and John H. Rust, eds. Springfield, Ill., Charles C. Thomas Publishers, 1964. 295p. $12.50.

Separate abstracts were prepared for 19 papers presented at this colloquium. A combined subject and author index is included. (C.H.)

For abstracts of individual chapters see: 11938, 11939, 11940, 11941, 11942, 11943, 11944, 11945, 11946, 11947, 11948, 11949, 11950, 11951, 11952, 11953, 11954, 11955, and 12427.

11938 COOPERATION BETWEEN RADIOLOGISTS AND APPARATUS DESIGNERS TO MINIMIZE RADIATION IN DIAGNOSTIC PROCEDURES. T. H. Rogers (Machlett Labs., Springdale, Conn.). p.3-14 of "The Reduction of Patient Dose by Diagnostic Radiologic Instrumentation." Springfield, Ill., Charles C. Thomas Publishers, 1964.

Procedures are outlined for the protection of patients and technicians during diagnostic radiology examinations. Emphasis is placed on the adjustment of x-ray equipment. (C.H.)

11939 MODERN TRENDS IN DIAGNOSTIC RADIOLOGIC INSTRUMENTATION. P. J. M. Botden (N. V.

Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). p.15-33 of "The Reduction of Patient Dose by Diagnostic Radiologic Instrumentation." Springfield, Ill., Charles C. Thomas Publishers, 1964.

Recent developments in instrumentation to reduce patient exposure during diagnostic radiography are reviewed. Topics discussed include x-ray tubes, dose meters, films and screens, image intensifiers, cineradiography and macroradiography techniques, and x-ray television. (C.H.)

11940 INSTRUMENTS FOR DOSE MEASUREMENT. E. Dale Trout and John P. Kelley (General Electric Co., Milwaukee). p.34-59 of "The Reduction of Patient Dose by Diagnostic Radiologic Instrumentation." Springfield, Ill., Charles C. Thomas Publishers, 1964.

Problems involved in the measurement of the small doses of x radiation associated with diagnostic procedures are reviewed. Instruments described that were developed for use in such measurements include a 4 mm by 5 mm ionization chamber for use in measurement of the entrance, depth, and exit dose in phantoms; preamplifiers, capacitors, and probes. Block diagrams are included of two basic types of measuring systems. Each system consists of a measuring chamber, a preamplifier for either dose or rate measurements and a direct current amplifier. The systems can be used to read exposure dose or dose rate directly, or the voltage may be nulled out by the insertion of a nulling voltage in the feedback loop. (C.H.)

11941 MEASUREMENT OF RADIANT ENERGY DELIVERED TO PATIENTS IN DIAGNOSTIC RADIOLOGY. Russell H. Morgan and Walter F. Ciceric (Johns Hopkins Univ. and Hospital, Baltimore). p.60-9 of "The Reduction of Patient Dose by Diagnostic Radiologic Instrumentation." Springfield, Ill., Charles C. Thomas Publishers, 1964.

Instrumentation with which the radiant energy delivered to patients in diagnostic radiology may be measured has been discussed from the standpoint of its use in epidemiological research and from its use in the assessment of the operating practices of physicians and technicians. Preliminary data are presented from an extensive study of the radiant energy levels used in diagnostic radiology. The ionization chamber used in the study is described. (C.H.)

11942 RELATIVE PATIENT DOSE IN CONVENTIONAL RADIOGRAPHY, TOMOGRAPHY, MULTISECTION RADIOGRAPHY, AND RADIOGRAPHIC SUBTRACTION. B. G. Ziedses des Plantes (Univ. of Amsterdam). p.70-7 of "The Reduction of Patient Dose by Diagnostic Radiologic Instrumentation." Springfield, Ill., Charles C. Thomas Publishers, 1964.

Tomography is used to obtain one or more x-ray pictures in which one plane of the object is pictured sharply while the image of the other parts of the object is blurred. The subtraction method is used to obtain a separate image of the difference between two radiographs. One radiograph is covered by a diapositive print of the other one in the subtraction method. Both of these methods require relatively high radiation exposure doses to the patient. Radiation dose to the patient resulting from conventional radiography, tomography, multisection radiography, and radiographic subtraction are discussed. (C.H.)

11943 PHYSICAL FACTORS IN CINEFLUOROGRAPHY. John Hale, David L. George, Robert D. Epperson, and Theodore A. Tristan (Univ. of Pennsylvania, Philadelphia). p.78-102 of "The Reduction of Patient Dose by Diagnostic Radiologic Instrumentation." Springfield, Ill., Charles C. Thomas Publishers, 1964.

Practical problems in estimating patient dose for a cinefluorographic unit with an automatic motion picture film exposure control system are discussed. An optimum performance curve which is called the radiation transfer function is defined. With this function, it is possible to compare the merits of cinefluorographic units of different design by evaluating overall system performance in terms of the ratio of the light exposure produced at the motion picture film to the absorbed dose at the patient. This approach to specification of the merit of cinefluorographic units is illustrated with data obtained from a typical apparatus. (auth)

11944 APPLIED OPTICS AND INFORMATION THEORY CONCEPTS IN TELEVISED IMAGE INTENSIFIER DESIGN. Robert D. Moseley, Jr., James R. Williams, and Ira H. Low (Univ. of Chicago). p.103-18 of "The Reduction of Patient Dose by Diagnostic Radiologic Instrumentation." Springfield, Ill., Charles C. Thomas Publishers, 1964.

Recent advances in the development of methods for amplification of a fluoroscopic image during diagnostic radiography are reviewed. Results are reported from investigations of resolution, brightness of the fluoroscopic image, lens design, the effects of x-ray quantum noise or statistical fluctuation, sensitivity and signal-to-noise ratio of image orthicon tubes, and steps that may be taken to improve diagnostic ability while concurrently decreasing patient dose to the lowest permissible limit. The application of television to replace direct optical viewing of image intensifiers is discussed. Several vidicon systems are described and evaluated. A system is described that uses an image orthicon tube, a television camera with fast lens system, and a transistorized camera control chassis that is remotely located. The capacity of the system to handle and transmit available information is discussed. (C.H.)

11945 CONVERSION AND INTENSIFICATION OF FLUOROSCOPIC IMAGES BY X-RAY IMAGE INTENSIFIER TUBES. Eckhard Fenner (Siemens-Reiniger-Werke Aktiengesellschaft, Erlangen, Ger.). p.119-29 of "The Reduction of Patient Dose by Diagnostic Radiologic Instrumentation." Springfield, Ill., Charles C. Thomas Publishers, 1964.

Recent developments in the design of x-ray image intensifier tubes for the conversion and intensification of fluoroscopic images during diagnostic radiographic examinations are reviewed. Contributions of image intensifier tubes to reduction of the dose of x radiation received by the patient are discussed. (C.H.)

11946 LATEST DEVELOPMENTS IN THE APPLICATION OF A DIRECT TELEVISION X-RAY IMAGE AMPLIFIER. E. Garthwaite (Marconi Instruments, Ltd., Longacres, St. Albans, Eng.). p.143-53 of "The Reduction of Patient Dose by Diagnostic Radiologic Instrumentation." Springfield, Ill., Charles C. Thomas Publishers, 1964.

The design and performance of a direct television x-ray image amplifier that uses the image orthicon for the whole of the amplification is described. The unit showed detailed contrast at the low screen doses encountered with obese patients. Photographs of typical films are presented. A dose measurement test set-up is described and results are reported from measurements of radiation dose to the patient when the image amplifier is used. (C.H.)

11947 QUANTUM STATISTICS OF X-RAY IMAGE INTENSIFYING SYSTEMS FOR FLUOROSCOPY. Paul J. Dolon and Wilfrid F. Niklas (Rauland Corp., Chicago). p.154-82 of "The Reduction of Patient Dose by Diagnostic Radiologic Instrumentation." Springfield, Ill., Charles C. Thomas Publishers, 1964.

X-ray image intensifying systems for use during fluoroscopic examinations are reviewed. Emphasis is placed on systems for direct visual observations and those that use image orthicon pickup. Schematic sketches of typical systems are presented and the quantum statistics of the systems are compared. (C.H.)

11948 KINESCOPIC RECORDING OF FLUOROSCOPIC INFORMATION: USEFULNESS AND LIMITATIONS. Earl R. Miller (Univ. of California, San Francisco). p.183-92 of "The Reduction of Patient Dose by Diagnostic Radiologic Instrumentation." Springfield, Ill., Charles C. Thomas Publishers, 1964.

A procedure is described for presenting x ray information obtained during fluoroscopic examinations. The system uses a 9-in. image intensifier and an image orthicon camera. The x-ray image is shown in the center of a 14-in. recording monitor. A vidicon camera is used to present additional information. The presentation of the two images is accomplished by synchronizing and mixing the video signals from the vidicon and the image orthicon cameras, and presenting them simultaneously on the monitor. Motion picture films were made with continuous x-ray exposure and televised information retained by a video tape recorder can be presented repeatedly. Methods to prevent loss of information with kinescopic recording are reviewed. (C.H.)

11949 OBSERVATIONS ON THE PERFORMANCE OF A STEREOSCOPIC TELEVISED FLUOROSCOPY SYSTEM. Herbert M. Stauffer (Temple Univ., Philadelphia). p.193-204 of "The Reduction of Patient Dose by Diagnostic Radiologic Instrumentation." Springfield, Ill., Charles C. Thomas Publishers, 1964.

The performance of a stereoscopic televised fluoroscopy system is discussed. (C.H.)

11950 RADIATION PROTECTION IN PHOTOFLUOROGRAPHY. Werner Lorenz (Universitat, Mainz). p.205-21 of "The Reduction of Patient Dose by Diagnostic Radiologic Instrumentation." Springfield, Ill., Charles C. Thomas Publishers, 1964.

The exposure of the individual or group to radiation is so limited when all necessary precautions are observed and modern techniques applied, that neither somatic nor genetic danger of any significance may be expected. It is concluded that mass chest x ray examinations by means of photofluorography is a valuable medical contribution in the search for unsuspected cases of lung tuberculosis among large groups. (auth)

11951 THE SPEED OF SYSTEMS AND IMAGE QUALITY. G. M. Ardran (Oxford Univ. and Atomic Energy Research Establishment, Harwell, Berks, Eng.), H. E. Crooks, and B. J. O'Loughlin. p.222-33 of "The Reduction of Patient Dose by Diagnostic Radiologic Instrumentation." Springfield, Ill., Charles C. Thomas Publishers, 1964.

Methods of reducing the radiation dose to both patients and staff during diagnostic radiographic examinations are summarized. The effects of fast systems on image quality are discussed in detail. (C.H.)

11952 THE INFLUENCE OF SHANNON'S INFORMATION THEORY ON DEFINITION AND MEASUREMENT OF IMAGE QUALITY. Herbert Schober (Universität, Munich). p.234-42 of "The Reduction of Patient Dose by Diagnostic Radiologic Instrumentation." Springfield, Ill., Charles C. Thomas Publishers, 1964.

The specification of image quality in terms of contrast-transfer-function (CTF) in the sphere of optics is reviewed. Applications of optical principles in radiology with regard to the CTF are discussed. (C.H.)

11953 GRIDS FOR IMAGE INTENSIFIER FLUOROSCOPY AND CINERADIOGRAPHY. Frank Dreisinger (Picker X-Ray Corp., Cleveland). p.243-55 of "The Reduction of Patient Dose by Diagnostic Radiologic Instrumentation." Springfield, Ill., Charles C. Thomas Publishers, 1964.

With currently available image intensifiers it is possible to fluoroscope and make cine films with radiation doses to the image tube as low as from 2 to 4 mr/min. At these radiation levels image quality suffers from insufficient x ray photon absorption. To the extent that a grid absorbs radiation, for a given exit dose from the patient (entrance dose to the image tube), the dose to the patient increases. For a given patient dose, more radiation is delivered to the intensifier if either no grid or low ratio grids are used. At low radiation levels increasing the dose to the system produces more improvement of image quality than reducing scatter from the patient. (auth)

11954 FILMS AND SCREENS IN DIAGNOSTIC RADIOGRAPHY. Emery Meschter (E. I. du Pont de Nemours & Co., Inc., Parlin, N. J.). p.256-8 of "The Reduction of Patient Dose by Diagnostic Radiologic Instrumentation." Springfield, Ill., Charles C. Thomas Publishers, 1964.

Recent improvements in fluorescent screens and photographic film systems for recording radiographic images are discussed. (C.H.)

11955 THE EFFICIENCY OF RADIOGRAPHIC INTENSIFYING SCREENS. M. M. Ter-Pogossian (Washington Univ., St. Louis). p.259-66 of "The Reduction of Patient Dose by Diagnostic Radiologic Instrumentation." Springfield, Ill., Charles C. Thomas Publishers, 1964.

In modern clinical roentgenography the exposure of the photographic emulsion results from the fluorescence of the x-ray intensifying screens that convert the energy of x-ray photons into electromagnetic radiations of considerably longer wave lengths, rather than from the direct action of x-ray photons upon the film. Thus, the speed and resolution of a roentgenogram depend on the physical characteristics of the intensifying screens rather than on the film emulsion. Results are presented from a study of the efficiency with which information carried by x-ray photons can be converted into optical information on the photographic emulsion. Emphasis is placed on the efficiency of x-ray intensifying screens and ways in which the efficiency may be improved. (C.H.)

11956 CAPSULE CONTAINING A PHARMACEUTICALLY USEFUL RADIOACTIVE MATERIAL. Howard S. Stern and Alexander Schlosser (to Olin Mathieson Chemical Corp.). U. S. Patent 3,121,041. Feb. 11, 1964. Filed July 20, 1960.

A water-soluble gelatin capsule is described for the gastrointestinal introduction of sodium iodide (I^{131}) for diagnostic purposes. (R.E.U.)

CHEMISTRY

General

11957 (AROD-1428:9) RESEARCH IN FLUORINE CHEMISTRY. Final Report, June 1, 1961 to February 28, 1963. John L. Margrave (Wisconsin. Univ., Madison). Contract AT(11-1)-Gen-7. 4p.

Research and development activities in the field of fluorine chemistry are summarized. Information is included on: synthesis of tetrafluorochlorates, formation of boron nitride and titanium oxides, properties and reactions of silicon fluorides and germanium fluorides, thermodynamic properties of fluorine compounds, and synthesis of halide compounds. (N.W.R.)

11958 (BNL-823(p.20-47)) CHEMISTRY AND CHEMICAL ENGINEERING DIVISION. O. E. Dwyer and R. H. Wiswall (Brookhaven National Lab., Upton, N. Y.).

Thermodynamic properties of the systems $NaCl-SrCl_2$ and $NaCl-BaCl_2$ were obtained from measurements on galvanic cells incorporating a porcelain membrane permeable only to Na ions. The system $NaCl-BaCl_2$ was found to be nearly ideal. A procelain permeable only to Li ions was also acquired, and with its help the properties of $LiCl-KCl$ mixtures were investigated. The absorption spectra of liquid $NaNO_3$ and KNO_3 were obtained in the ultraviolet. The nitrate ion has a very strong band around 2000 to 2100 Å. Perfluoronaphthalene, $C_{10}F_8$, was irradiated in the electron Van de Graaff accelerator. Higher molecular weight products were formed with a G value of 1.3. A compound of Kr, KrF_2, was prepared by electron irradiation of a mixture of the elements at –150°C. It is unstable at room temperature. Stable graphite filaments for studying sublimation temperature as a function of C/H ratio were obtained by heating in Ar. It was found that at 2500°K, H_2 caused slow evaporation of C while a small amount of CH_4 caused rapid deposition of C. The results gave sublimation temperatures ≈100°C above the theoretical calculations of Duff and Bauer. In studying the surface areas of nuclear graphites as a function of particle size, AGOT, TSX, and ZTA were measured down to 200 mesh (70 μ). AGOT and TSX have approximately the same specific surface areas when they are subdivided to <100 mesh (150 μ). When subdivided ZTA had a much larger surface area and the results indicated that it contains many closed pores which are <70 μ diam. ZTA also contains fine filaments. In general, the specific surface of graphite particles was found to be a constant plus a term which is proportional to the geometrical surface area. Preparations were continued for the demonstration of the Nitrofluor Process dissolution step on a complete STR-type fuel element in $NOF-N_2O_3-HF$, formerly called NOF · 3.1 HF. The equipment was made of Monel, except for a few Ni items. Corrosion tests on Monel and Ni in contact showed satisfactory performance. A method was worked out for removing complex Zr salt from the system by dissolving it in concentrated NH_4OH. The effect of partial exhaustion of solvent on dissolution rate was measured, in order to determine conditions which give good solvent utilization without permitting dissolution rates to fall below an acceptable value. The solvent, which was prepared by reacting commercial NOCl with HF and distilling out the HCl formed, was shown by the spectrophotometric methods to contain N_2O_3. It is believed to be a ternary azeotrope of NOF, HF, and N_2O_3, boiling at 92° to 95°C. Under vacuum distillation it yields mixtures of a wide range of composition and normal boiling point. The N_2O_3 content is not large, which accounts for the formula NOF · 3.1-HF formerly ascribed to this material. The binary azeotrope of N_2O_3 and HF, boiling around 68°, may prove useful as a dissolution reagent. For most fuel element materials it was as good a solvent as the ternary azeotrope, and it should be possible to make it more cheaply. Recent experiments showed that N_2O_3 can be made by heating $NaNO_2$ with P_2O_5. This azeotrope, however, has the disadvantage of requiring Ni equipment. The reaction of NOF solutions with metals forms complex compounds which in some cases are volatile at elevated temperatures (e.g., $NOUF_6$). The volatility of four fission product elements (Cs, Sr, La, and Te) after reaction with $NOF-N_2O_3-HF$ was determined. The compounds formed by the first three of these were nonvolatile at 230 to 245°C, while the Te compound was volatile at 160°C, in an evacuated system. It condensed at 100°C. The corrosion kinetics of Monel and Ni in 30% NO_2–70% HF were studied at several temperatures, using a technique exploiting the change in resistance of a wire probe. On Monel, the film formed at 75°C was soft and nonprotective, but films formed at 125 or 150°C were hard and so protective that within hours the growth rate became undistinguishable from zero. These films remained protective on cooling and reheating. With Ni rates were lower than for Monel at 100°C, but at 125 and 150°C the films were less protective and the rates remained finite. They were not large, however; after 100 hr at 125°, the rate was only 0.2 mil/year. It was found that stainless steel is severely attacked by reaction with oxygen at 700°C in an agitated bed of alumina containing 1 to 5 wt % metal fluorides (AlF_3, FeF_3, or CoF_3). Data on the effect of variations in fluoride concentration and of temperature were obtained by using a rotating bed system. The phosphate glass pilot plant was operated on an intermittent basis and the major components were tested under actual glass-making conditions. Material balances for the entire process were made which will form the basis for preliminary engineering design calculations. A number of possible materials of construction for the off-gas system were tested for their resistance to corrosion. Several process schemes are presently being evaluated. The chemical state of iodine released from U in steam was studied over the temperature range 1000 to 1320°C. More than 85% of the iodine released from U irradiated to 3.0×10^{14} nvt was collected as iodide ions in the aqueous condensate. In contrast to these results, >99% of the iodine released from U irradiated to 5.4×10^{19} was found as iodide ions. The chemical state of the iodine is evidently a function of the reaction kinetics between atomic iodine and the H_2 formed by the reaction of H_2O and U. In He, the iodine was apparently released primarily as uranium iodide at 1200°C. An experiment at 1750°C showed that this compound is partly dissociated at this temperature and some elemental iodine is released together with the uranium iodide. By using an emf cell for measuring the free energy of formation of UI_3, preliminary measurements at 320°C indicated a value of 97 ± 10 kcal, which is about 10 kcal less than the present literature value. In an experimental project involving the flow of Hg through annuli, the first results were obtained. Velocity profiles under both isothermal conditions,

and under conditions of heat transfer from the inner wall, turned out well and agreed with expectations. However, pressure drop results were slightly higher than expected. Temperature profiles were also obtained. Nusselt numbers from these, and also from surface thermocouple measurements and bulk temperatures, agreed well with theoretically predicted values. The main purpose of this work, however, is to measure eddy conductivities of both heat and mass transfer, and to determine how they depend upon the operating variables. (auth)

11959 (TID-20168) FINAL REPORT [ON CHEMISTRY], JANUARY 31, 1964. W. Wayne Meinke (Michigan. Univ., Ann Arbor. Dept. of Chemistry). Contract AT (11-1)-1143. 37p.

The research program on nuclear chemistry, radiochemical separations, and activation analysis is outlined. The facilities and the present status of the program are described. A bibliography is presented of 143 research papers and 164 talks that were prepared under the program. (D.L.C.)

Analytical Procedures

Refer also to abstract 12329.

11960 (AD-410234) DEVELOPMENT OF ANALYTICAL TECHNIQUES FOR THE DETERMINATION OF MINUTE QUANTITIES OF SELECTED ELEMENTS IN BERYLLIUM. Final Report, June 6, 1962 through June 6, 1963. (Battelle Memorial Inst., Columbus, Ohio). July 22, 1963. Contract NOw-62-0629-c. 42p.

Development efforts were carried out on vacuum-spark mass spectrography, on activation oxygen analysis, and, to a lesser extent, on vacuum-fusion analysis, emission spectroscopy, chemical nitrogen analysis, and conductometric carbon analysis methods. The results of the efforts, together with analytical data and complete descriptions of the experimental work, are given. Mass spectroscopy provides for detection of metallic impurities at concentrations considerably less than 1 ppm and, with some additional standardization, with good accuracy. (auth)

11961 (AEET/Anal./28) A COMPILATION OF DATA FOR ACTIVATION ANALYSIS BY (n,γ) REACTION. S. Gangadharan, R. Krishnamoorthy Iyer, and M. Sankar Das (India. Atomic Energy Establishment, Trombay). 1963. 44p.

A compilation is presented of data for neutron irradiation and gamma counting. The data includes the saturation activities of different radioisotopes produced by the (n,γ) reaction, half lives of the nuclides produced, decay modes, gamma-ray energies and intensities, and possible interferences. (D.L.C.)

11962 (GEAP-4271) THE MEASUREMENT OF OXYGEN TO METAL RATIO IN SOLID SOLUTIONS OF URANIUM AND PLUTONIUM DIOXIDES. W. L. Lyon (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). May 31, 1963. Contract AT(04-3)-189. 32p.

A survey was made of metheds potentially useful for the determination of the oxygen to metal ratio in mixed oxides of uranium and plutonium. A gravimetric method was selected as being the most promising for adaptation in a short period of time. Development of the technique resulted in a reliable method which meets the requirements for unirradiated mixed oxide fuel samples. The method, based upon an equilibrium weight at 700°C in dry hydrogen, was shown to be capable of measurement of O/(Pu + U) ratios in 20% PuO_2–80% UO_2 pellets with a standard deviation of ±0.001. (auth)

11963 (HW-53368(Suppl.1)) PLUTONIUM OXIDATION-REDUCTION TITRATIONS. R. J. Kofoed, Jr. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 1963. Contract AT(45-1)-1350. 34p.

For the accurate measurement of Pu contents in process streams, Pu is usually determined on a milligram scale by reducing Pu to the trivalent state followed by quantitative oxidation to the tetravalent state by ceric sulfate. The principle of the method is discussed in detail, and the factors affecting the oxidation-reduction titration are described. Equipment for the titration is also described. Other potentiometric methods for Pu are considered briefly. Finally, procedures are given for the determination of Pu in Pu metal, alloys, and process solutions. (D.L.C.)

11964 (HW-79296) CONTINUOUS MEASUREMENT OF TRACE CONCENTRATIONS OF AMMONIA IN WATER. T. F. Demmitt (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1963. Contract AT(45-1)-1350. 11p.

Results are presented of an evaluation of the alkaline phenol-sodium hypochlorite procedure for continuous measurement of trace concentrations of ammonia in water. The analytical procedure and instrumentation used are also described. The ammonia concentration range investigated was 0 to 25 ppm. The precision of the procedure is within ±10% at the 10 ppb level and ±2% at the 25 ppm level. This procedure is recommended for measurement of ammonia concentrations in aqueous process streams where NH_4OH is used for pH control. (auth)

11965 (K-1400) ISOTOPIC RATIO MEASUREMENT ERRORS CAUSED BY ION INTERACTIONS WITH IMPURITY MOLECULES. V. L. Warren and J. C. Horton (Oak Ridge Gaseous Diffusion Plant, Tenn.). Feb. 14, 1964. Contract W-7405-eng-26. 21p.

Impurity or residual gases in the ion source and/or analyzer region of a mass spectrometer cause errors in the measurement of isotopic ratios. The effect in uranium hexafluoride analyses is studied. This apparent ratio change is due to ion beam distortion produced by ion-molecule interactions. Both symmetrical and non-symmetrical ion beam spread are observed and attributed primarily to small-angle elastic scattering with energy loss. Charge exchange, ionization by positive ion impact, partial beam neutralization, and other effects do not seem to contribute significantly. (auth)

11966 (MCW-1482(p.11-18)) THE DETERMINATION OF OXYGEN IN FUSED FLUORIDE ELECTROLYTES BY VACUUM FUSION USING MASS SPECTROMETRIC MEASUREMENT. L. G. Lueders and H. F. Waldron (Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Mo.).

A method is described for the determination of oxygen in BaF_2–LiF–UF_4 and CaF_2–LiF–UF_4 electrolytes. A small mass-spectrometer unit is used to measure CO and CO_2 formed by the reaction of oxygen in the sample with the graphite fusion crucible. For an individual determination, a precision of ±60 ppm at the 95% confidence level is found with samples containing 900 to 1800 ppm oxygen. (auth)

11967 (MCW-1482(p.37-46)) A GENERAL METHOD FOR THE DETERMINATION OF TRACE ELEMENTS IN HIGH-PURITY MAGNESIUM METAL. J. R. Nelms and

R. S. Vogel (Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Mo.).

A new spectrochemical method was developed for the determination of boron, cadmium, manganese, silicon, and zinc in high-purity magnesium metal. The method, applicable to both granular and ingot magnesium, is based on a carrier-distillation technique using 16.4 mole % strontium fluoride in silver chloride as the carrier. An arrangement of focal plane filters is used to attenuate the photographic line intensity of selected analytical element lines of manganese, silicon, and zinc so as to permit the determination of all the required elements in an efficient one-step spectrum exposure, instead of the usual multiple-step sector-type exposure. A spectrophotometric method used for the determination of iron in ground and ingot magnesium is also described. (auth)

11968 (NP-13501) THE DETERMINATION OF MICROGRAM QUANTITIES OF CERTAIN HEAVY METALS. D. B. Adams (Laporte Chemicals Ltd., Luton, Beds, England). June 1963. 16p.

A procedure was developed to determine copper, iron, cobalt, and manganese at the 0.01 ppm level in a wide range of materials. A scheme of successive solvent extraction using selective colorimetric reagents is applied after a preliminary concentration of all four metals by extraction of their diethyldithiocarbamate complexes. The sensitivities of the methods used are enhanced by keeping the final volume for measurement as small as possible. (auth)

11969 (PAN-452/XIX) WATER CONTAMINATION CONTROL BY DIRECT MEASUREMENT OF BETA RAYS. S. Pszona (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Aug. 1963. 12p.

A short mathematical discussion of beta radiation above the surface of contaminated water is made. Measurements of beta-count rate above the surface of water contaminated with known amounts of S^{35}, Co^{60}, W^{185}, Tl^{204}, and P^{32} with the end-window G-M counter are carried out. The results of measurements are in good agreement with the mathematical analysis. (auth)

11970 (PG-Report-464) ANALYTICAL METHOD FOR THE SPECTROGRAPHIC DETERMINATION OF BORON IN CAST URANIUM METAL USING THE CARRIER DISTILLATION TECHNIQUE. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1964. 9p.

The uranium metal is converted to U_3O_8 by ignition and is then mixed with ammonium fluoride carrier. Charges of the mixture are spectrographed using the carrier distillation technique. Chemically analyzed samples are used for the preparation of calibration curves. Spectra are evaluated by means of either a non-recording microphotometer or cathode ray microphotometer, depending on the concentration of boron present. The method is applicable to samples of uranium metal containing between 0.02 and 0.6 ppm boron. For concentrations between 0.02 and 0.2 ppm boron, a cathode ray microphotometer is used to evaluate the spectra. The precision at the 0.09 ppm level is ±20 to 25% (3 × sigma). (auth)

11971 (PG-Report-526) ANALYTICAL METHOD FOR THE DETERMINATION OF FREE CARBON IN URANIUM CARBIDE. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1964. 11p.

The sample is treated with 1:1 hydrochloric acid to dissolve any combined carbon compounds. Any free carbon is left undissolved as a black suspension. This is filtered on to a prepared gooch crucible and after thorough washing and drying, the crucible and its contents are placed in a combustion tube at 950 to 1000°C and any carbon present is determined by measuring the carbon dioxide produced using a gasometric method. The method is applicable to uranium carbide or any substance containing free carbon which may be separated by treatment with dilute non-oxidising acid. The standard deviation, determined from duplicate results of a variety of samples, is ±22 ppm. 83 duplicate determinations were used to obtain this estimate and the general level of free carbon was 100 ppm. (auth)

11972 (PG-Report-532) ANALYTICAL METHOD FOR THE DETERMINATION OF BORON IN PURIFIED AND NATURAL WATERS (EXCLUDING SEA-WATER). (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1964. 7p.

An aliquot of the sample is evaporated to dryness with sodium hydroxide, and the boron is determined absorptiometrically on the residue as the curcumin complex. The method is applicable to water containing 0.005 to 0.05 ppm boron. The standard deviation obtained from 12 recoveries at the 0.25 μg level was 0.014 μg. (auth)

11973 (PG-Report-540) ANALYTICAL METHOD FOR THE DETERMINATION OF CARBON IN CARBON STEELS AND STAINLESS STEELS. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1964. 12p.

The steel in the form of swarf or turnings is ignited at 1350°C in an oxygen stream. The carbon dioxide evolved is isolated by means of a cold trap cooled in liquid oxygen and measured after expansion at room temperature, as a gas volume. The method is applicable to carbon and stainless steels in the form of swarf, millings, turnings or powder. On British Chemical Standards, carbon steel stated to be 0.32% carbon, a value of 0.32%, with a standard deviation of ±0.0045% for a single measurement, was obtained on nineteen tests. On British Chemical Standards, 18/12 stainless steel stated to be 830 ppm C, a value of 840 ppm, with a standard deviation of ±23 ppm for a single measurement, was obtained on 12 tests. (auth)

11974 (PG-Report-552) ANALYTICAL METHOD FOR THE DETERMINATION OF CHLORINE IN CARBON DIOXIDE. (United Kingdom Atomic Energy Authority. Production Group, Windscale, Sellafield, England). 1964. 6p.

The sample is mixed with oxygen and heated to 1000°C when chlorinated hydrocarbons break down and free chlorine is released. This is absorbed in a solution of sodium sulphite and sodium carbonate and the chloride produced determined spectrophotometrically. The method is mainly intended for the determination of the total chlorine in the carbon dioxide feed gas or circuit gas of gas cooled reactors of the Calder Hall or A.G.R. type. It is not specific for chlorine, other halogens reacting in a similar manner. The concentration range is 0.2 to 100 ppm w/w in chlorine. (auth)

11975 (AEC-tr-6304) SODIUM SAMPLING DEVICE ON A CIRCUIT FOR IMPURITY ANALYSES. J. Sannier and R. Vingot. Translated for Oak Ridge National Lab., Tenn., from Paper Presented at the Liquid Metals Colloquium of the European Society of Atomic Energy Aix-en-Provence, Cadarache, Sept. 30–Oct. 2, 1963. 9p.

The equipment described was developed in consideration of the following two essential requirements: (1) Absence of any contamination during the sampling and

transport operations leading to the analytical equipment. (2) Simultaneous recovery of several samples, each remaining representative of the sodium in the circuit. For this purpose, sampling was carried out entirely under vacuum in a Pyrex glass equipment, which limits the temperature of the sodium to 240°C. The samples are obtained in the form of sealed ampules under vacuum and each contains 2 to 3 g of sodium. The analysis for oxygen by the amalgamation technique, conducted with samples obtained by this method, reveals a very satisfactory reproducibility in the range of concentrations below 20 ppm. (auth)

11976 SEVERAL THEORETICAL QUESTIONS RELATIVE TO RADIOMETRIC TITRATION. Viktor Jesenak and Juraj Toelgyessy (Slovak Technical School, Bratislava). Acta Chim. Acad. Sci. Hung., 32: 397-406(1962). (In German)

The theory of radiometric titrations based on precipitate formation is discussed. If a salt AB is formed, the equation for its solubility product, $L_{AB} = [A^+]\,[B^-]$ is valid only for a saturated solution after the initial precipitation of AB. The solubility product also depends somewhat on the composition of the solution. In the case of titration of an active sample with an inactive solution the activity of the solution above the precipitate *AB is proportional to the concentration of A^+. The titration curve decreases hyperbolically or in a shape that approximates two straight lines. If an inactive sample is titrated against an active titration solution, the activity of the bulk solution above the precipitate A*B is proportional to the concentration of B^-. The titration curve increases almost linearly. When an active sample is titrated against an active solution the activity of the bulk solution initially decreases while formation of the precipitate *A*B reduces the concentration of the $*A^+$ ion. After reaching a minimum the activity of the solution increases because of the addition of the $*B^-$ and approaches a value limited by the total activity added. (TCO)

11977 ANALYSIS OF PETROLEUM PRODUCTS BY ABSORPTION OF RADIOACTIVE RADIATIONS. I. SOME CONSIDERATIONS CONCERNING THE ACCURACY OF MEASUREMENTS OF RADIOACTIVE RADIATION ABSORPTION. T. Bálint (Hungarian Petroleum and Natural Gas Research Inst., Veszprem). Acta Chim. Acad. Sci. Hung., 39: 161-70(1963).

Factors affecting the accuracy of measurements, elimination of undesirable effects, and the optimum values of the freely choosable variables of the measurement of radiation absorption (quality and activity of radiation source, dimension of cuvette, amount of substance weighed, method of detection, duration, and method of measurement) in the case of a given analytical task are discussed. (P.C.H.)

11978 ANALYSIS OF PETROLEUM PRODUCTS BY ABSORPTION OF RADIOACTIVE RADIATIONS. II. DETERMINATION OF HYDROGEN CONTENT BY MEASURING THE ABSORPTION OF β-RADIATION WITH IONISATION CHAMBERS. T. Balint (Hungarian Petroleum and Natural Gas Research Inst., Veszprem). Acta Chim. Acad. Sci. Hung., 39: 171-82(1963).

On applying the principles of differential photometry, the factors affecting the accuracy of the determination of hydrogen by measuring the absorption of β-radiation with ionization chambers were thoroughly investigated. On using the principles of differential photometry, it is possible to establish the optimum values of the radiation source used for the measurement and of the cuvette. Moreover, the effect of errors committed in measuring the ionization current on the accuracy of measurement can be calculated, and the best method of measuring can be developed. The investigations proved that it is not worth while to increase the accuracy of the measurement of radiation absorption when the density measurement cannot be carried out more accurately at the same time. (auth)

11979 ELECTRIC ANALOG INTEGRATOR FOR SIMULTANEOUS LINEAR AND INTEGRAL GRAPHIC RECORDING. J. Thomas Dowling and Charles J. Goodner (Univ. of Seattle). Am. J. Med. Electron., 2: 143-6(Apr. 1963).

Electronic techniques for scanning chromatograms containing radioisotopes are discussed. The need for long periods of integration has precluded use of fully electronic methods; however, the availability of high performance d-c amplifiers now allows construction of an integrator that provides the advantages of versatility and of visually presented integrals that are recorded simultaneously with the basic linear curve. The number of events distributed over a specific time interval is used as the input for the integrator; the current proportional to the number of disintegrations detected from radiochemicals distributed on a chromatogram is provided from a detector and count-rate meter. The mean counting rate occurring while the chromatogram moves at a constant rate beneath the detector is traced by a recording galvanometer. Voltage proportional to this current is applied to the input of a d-c amplifier that activates an external integrating circuit. Among several amplifiers studied the d-c amplifier described proved to be the most suitable. This amplifier employs a preamplifier and balanced differential stage in order to minimize drift of the output due to power supply fluctuations. Chopper stabilization is used to reduce error voltages that arise from vacuum tube noise. The circuit used is illustrated. Time constants of integration are 1, 2, 10, and 50 sec. The maximum drift of the instrument under either zero input or hold (capacitor charged, no input) is less than 5 mv/hr, and instrument error due to drift is less than 0.004%. Simultaneous linear and integral curves are depicted representing the scan of a chromatogram of hydrolyzed thryoglobulin containing I^{131} in inorganic and organic form. The procedure for calculations of areas under individual curves as percentages of the total area is outlined. (BBB)

11980 COMBUSTION METHOD FOR ESTIMATION OF DEUTERIUM IN ANIMAL TISSUES. Hyman Rosen (Walter Reed Army Medical Center, Washington, D. C.). Anal. Biochem., 7: 215-17(Feb. 1964).

A closed combustion technique is described for deuterium analysis in animal tissues. One to two hundred milligrams of tissue is placed in a 500-ml Parr bomb and the bomb is filled with 35 lb/sq in. of pure dry oxygen. After combustion, the bomb is cooled to room temperature and fitted with a specially designed cover. Analysis is done by the infrared technique, according to Turner. Curves were prepared from standard D_2O solutions. Glycine was run through the entire procedure, as a check. Replicate analysis gave results that differed maximally by 0.03 at.%. (H.M.G.)

11981 A SIMPLE SENSITIVE GEIGER COUNTER FOR SCANNING CHROMATOGRAMS (A SIMPLE RADIOCHROMATOGRAM SCANNER). S. H. Shipotofsky (Proctor and Gamble Co., Cincinnati). Anal. Biochem., 7: 233-9(Feb. 1964).

A simple, sensitive, yet versatile Geiger counter for scanning paper chromatograms was developed. The device

may be operated either as a windowless detector for maximum sensitivity or with ultra thin windows to maintain a high level of sensitivity yet minimize contamination problems for routine work. Easily constructed Geiger flow-through tubes having very similar operating characteristics are described. The device was designed to provide maximum sensitivity and versatility at low cost. (auth)

11982 ANALYTICAL APPLICATIONS OF THE FLAME SPECTRA OF THE RARE EARTH ELEMENTS AND SCANDIUM. Arthur P. D'Silva, Richard N. Kniseley, Velmer A. Fassel, Ronald H. Curry, and Robert B. Myers (Ames Lab., Ames, Iowa). Anal Chem., 36: 532-6(Mar. 1964). (IS-732)

The analytical potentialities of the simple spectra emitted by the rare earth elements when ethanol solutions of their perchlorates are aspirated into fuel-rich, oxyacetylene flames are evaluated. The sensitivities of detection of the strongest lines are tabulated and data showing the application of these spectra to the analysis of complex rare earth mixtures are presented. The relative standard deviations for these analyses ranged from ±1.3 to 3.7% of the amount present. (auth)

11983 FLAME PHOTOMETRIC DETERMINATION OF STABLE STRONTIUM IN ENVIRONMENTAL MEDIA. Lawrence A. Elfers, Paul F. Hallbach, and Richard J. Velten (Robert A. Taft Sanitary Engineering Center, Cincinnati). Anal. Chem., 36: 540-3(Mar. 1964).

An analytical procedure for the determination of strontium in environmental media by flame photometry at 461 mμ is described. Strontium and other alkaline earths are separated from interfering ions such as phosphate by oxalate and nitrate precipitations. Calcium is removed by ion exchange chromatography after preferential chelation with Versene at pH 5.0. Monovalent ions are washed from the ion exchange resin with 0.5N HCl prior to eluting strontium and barium with 3N HCl. Strontium-85 tracer is used to monitor strontium losses during purification. As little as 0.05 mg of strontium may be measured with 5% error. Strontium was determined in food, water, excreta, and bone by this method. (auth)

11984 SIMULTANEOUS DETERMINATION OF OXYGEN AND SILICON IN METEORITES AND ROCKS BY NONDESTRUCTIVE ACTIVATION ANALYSIS WITH FAST NEUTRONS. James Wing (Argonne National Lab., Ill.). Anal. Chem., 36: 559-64(Mar. 1964).

The weight ratios of oxygen to silicon, per cents of oxygen, and per cents of silicon in Plainview, Karoonda, Atlanta, Murray, Orgueil, Manbhoom, Vigarano, Richardton, and Mokoia meteorites and in G-1 and W-1 rocks were determined nondestructively by activation with 14-Mev neutrons. These quantities were obtained by simultaneously counting the gamma activities of nitrogen-16 and aluminum-28 produced in the $O^{16}(n,p)N^{16}$ and $Si^{28}(n,p)Al^{28}$ reactions, respectively, using quartz as the reference. Two counting methods were used: one following the nitrogen-16 and aluminum-28 activities by two single-channel analyzers; the other recording the γ-energy spectra of the irradiated samples by a 200-channel analyzer. The results are compared with those obtained by other methods. The sensitivities of the present method are 1000 ppm for oxygen and 250 ppm for silicon, each with an estimated error of 5%. (auth)

11985 A PRACTICAL APPROACH TO THE SELF-SHIELDING PROBLEM IN LOW-FLUX NEUTRON ACTIVATION ANALYSIS. Oswald U. Anders (Dow Chemical Co., Midland, Mich.). Anal. Chem., 36: 564-8(Mar. 1964).

Methods to measure the average fast and thermal neutron flux to which an analytical sample is exposed during activation are discussed and evaluated. The widely used method of thermal neutron flux determination by means of externally attached pieces of gold foil is shown to result in errors of up to 500% and more for samples of large macroscopic cross section materials. The newly proposed method of inserting a thin gold wire as flux monitor into the axis of cylindrical samples by means of a hypodermic needle is found to reduce such large errors to less than 15% for 7-ml cylindrical samples of 1.45-cm diameter, if $\Sigma_a \leq 6$ cm^{-1}. (auth)

11986 SIMULTANEOUS DETERMINATION OF RADIOISOTOPE PAIRS BY THE DECAY CONSTANT DIFFERENTIATION PRINCIPLE. Edgar Inselberg (Univ. of Pittsburgh). Anal. Chem., 36: 568-75(Mar. 1964).

A theoretical model for predicting precision indexes and determining optimum conditions for differentially detected radionuclides was validated with synthetic activities. The variability associated with a radioassay procedure can be partitioned into two major components, the component ascribed to the random nature of radioactive decay and that attributable to procedural errors. The precision indexes of simultaneously determined isotopes can be expressed as functions of nine variables. The variability of each isotope, however, has a minimum only with respect to the time elapsing between the two counts of the mixed activity. Since the minima for the two isotopes do not coincide, optimum conditions may be attained by minimizing the sum of per cent standard errors (joint precision index) with respect to time and imposing the constraint that their ratio shall have some desired value. The above treatment is also applicable to the simultaneous assay of two radioisotopes by differential absorption. (auth)

11987 A NEW TECHNIQUE FOR ASSAY OF OXYGEN-18 IN SULFUR DIOXIDE. T. M. Spittler and J. L. Huston (Loyola Univ., Chicago). Anal. Chem., 36: 575-7(Mar. 1964).

The method consists of a spark-induced exchange of oxygen between equimolar amounts of sulfur dioxide and carbon dioxide gases. Complete exchange is found after 6 minutes of sparking the mixture. Sulfur dioxide is destroyed by shaking the gases with a saturated solution of potassium dichromate in 96% sulfuric acid. The undissolved carbon dioxide is assayed for oxygen-18 in an isotope ratio mass spectrometer. A standard curve is prepared by sparking a series of labeled sulfur dioxide samples of varying oxygen-18 content with unlabeled carbon dioxide and plotting per cent isotope excess vs isotope ratio of the carbon dioxide taken from the exchange process. The curve is used to assay labeled sulfur dioxide samples before and after an exchange reaction. The relative error of the method is about ±2%. The technique is compared with existing methods for sulfur dioxide assay. (auth)

11988 PRECIPITATION OF SUBMICROGRAM QUANTITIES OF THORIUM BY BARIUM SULFATE AND APPLICATION TO FLUOROMETRIC DETERMINATION OF THORIUM IN MINERALOGICAL AND BIOLOGICAL SAMPLES. Claude W. Sill and Conrad P. Willis (Atomic Energy Commission, Idaho Falls, Idaho). Anal Chem., 36: 622-30(Mar. 1964).

An efficient method is described for the separation of thorium from relatively large biological and mineralogical samples. From 100 to 10^{-5} μg of thorium is precipitated to better than 99.5% by 25 mg of barium or other elements forming insoluble sulfates from 75-ml volume. The sepa-

ration takes place from strongly acidic solutions and is not affected appreciably over a wide range of experimental conditions. The barium sulfate is dissolved in alkaline DTPA and the thorium is determined directly in the alkaline solution by a fluorometric procedure, which was applied to the following types of samples with the detection limits indicated: rocks, 2×10^{-6}%; bone ash, 5×10^{-7}%; feces, liver, and grain, 2×10^{-8}%; urine, 10^{-11} gram per ml; and blood 2×10^{-10} gram per ml. (P.C.H.)

11989 SIMULTANEOUS DETERMINATION OF SULFUR AND PHOSPHORUS IN WATER BY NEUTRON ACTIVATION ANALYSIS. Cooper H. Wayman (Geological Survey, Denver). Anal. Chem., 36: 665-6(Mar. 1964).

The determination of both sulfur and phosphorus in solution by measurement of the total beta activity in terms of P^{32} by neutron activation analysis is described. Sulfur and phosphorus may be determined in water by irradiation of two samples containing these constituents, one sample being shielded with cadmium foil and the other unshielded. The results indicate that phosphorus can be reasonably detected at the 0.01–10.0 ppm level, when sulfur is also in solution, without serious interference. Sulfur may be detected at a minimum concentration of 0.1 ppm if the phosphorus content in solution does not exceed 1.0 ppm. In natural water sulfur can be semiquantitatively detected in the range 100 to 200 ppm without serious error by the double irradiation technique. (P.C.H.)

11990 IMPROVED DETERMINATION OF STRONTIUM-90 IN MILK BY AN ION EXCHANGE METHOD. Charles R. Porter and Bernd Kahn (Southeastern Radiological Health Lab., Montgomery, Ala. and Robert A. Taft Sanitary Engineering Center, Cincinnati). Anal. Chem., 36: 676-8(Mar. 1964).

An improved procedure is described for the determination of Sr^{90} in milk by ion exchange. The procedure consists of storing the milk samples with formaldehyde preservative for the ingrowth of the Y^{90} daughter of Sr^{90}, adding Y carrier, and then passing the milk consecutively through cation and anion exchange resin columns. The alkaline earth ions in milk are replaced by sodium ions in the cation exchange column, after which the Y is retained as an anionic complex, sodium citrate, in the anion exchange column. The effluent milk is discarded and the Y complex on the anion exchange resin is destroyed with HCl. The Y, eluted with the acid, is precipitated as the oxalate, and the radioyttrium is measured with a low-background beta counter. (P.C.H.)

11991 180° COMPTON SCATTERED-ANNIHILATION GAMMA-RAY SUM PEAK OBSERVED IN GAMMA-RAY SPECTROMETRY. W. S. Lyon (Oak Ridge National Lab., Tenn.). Anal. Chem., 36: 682-3(Mar. 1964).

Studies were made on the gamma spectra obtained when a source of Cu^{64} is measured at high and low geometries, both unshielded and encapsulated. An enhanced summing effect at high geometry with a large amount of scattering material present was observed. When the source is encapsulated in wax, the result is annihilation and scattering close to the source of the positrons emitted in all directions. Thus, the conditions are maximized for the production of a sum peak. The distribution of Compton electrons from scattering results in a sharp maximum corresponding to 180° scattering. (P.C.H.)

11992 DETERMINATION OF CARBON-14 IN HALOGENIC COMPOUNDS BY AN OXYGEN FLASK METHOD. Horace E. Dobbs (Atomic Energy Research Establishment, Wantage, Berks, Eng.). Anal. Chem., 36: 687-9(Mar. 1964).

Investigations showed that the oxygen flask method can be successfully applied to the assay of C^{14} in halogenic compounds. No modification of the standard procedure is required after the combusion of chlorinated compounds, which results in a slight lowering of the counting efficiency. To obtain reliable and reproducible results it is necessary to modify the method after burning substances containing bromine and iodine. The incorporation of 10% v/v 2-pentene in the phosphor prevents considerable reduction in counting efficiency encountered after the combustion of brominated samples. (P.C.H.)

11993 LOSS OF CESIUM-137 IN THE ASHING OF MILK SAMPLES. Roy M. Green and Raymond J. Finn (Australian Atomic Energy Commission Research Establishment, Sutherland, New South Wales). Anal. Chem., 36: 692-3(Mar. 1964).

Milk samples were ashed at temperatures ranging from 400 to 750°C and the percentage of Cs^{137} lost from the sample during the ashing process was determined. Appreciable losses for temperatures above 550°C were found. It was concluded that a furnace temperature of 450°C is perfectly safe for ashing purposes, even when samples with high organic content are being ashed. The results indicate that in ashing at this temperature the only loss to be expected is due to adsorption by the crucible used, which should be only a few per cent at most. (P.C.H.)

11994 THE DETERMINATION OF CAESIUM-137 IN IRRADIATED URANIUM BY USING THE RING-OVEN TECHNIQUE AND GAMMA-RAY SPECTROMETRY. D. A. Hilton and D. Reed (Central Electricity Generating Board, Berkeley, Gloucestershire, Eng.). Analyst, 89: 132-5 (Feb. 1964).

A ring-oven method is described for determining cesium-137 in irradiated uranium solutions. A small drop of the solution is placed on a pre-formed ferric hydroxide precipitate situated at the center of a filter-paper. The paper is positioned on a ring oven, and washed with ammonia solution and water. The cesium-137 migrates to the ring zone, and the other fission products and uranium stay in the center of the paper. The cesium-137 in the ring zone is determined by using a γ scintillation spectrometer. The method compares well with an ion-exchange procedure. (auth)

11995 THE CEROMOLYBDATE METHOD FOR THE DETERMINATION OF RADIOCESIUM. Vikt. I. Spitsyn, E. A. Torchenkova, and G. G. Stepanova. At. Energ. (USSR), 15: 519-20(Dec. 1963). (In Russian)

A method was developed for the determination of radiocesium by treating it with ammonium ceromolybdate followed by a colorimetric measurement of the yield in the form of ammonium cesium ceromolybdate. During this study, the structures of 2 formerly unknown salts, $2Cs_2O \cdot CeO_2 \cdot 12MoO_3 \cdot 11H_2O$ and $(NH_4)_2O \cdot 2Cs_2O \cdot CeO_2 \cdot 12MoO_3 \cdot 8H_2O$ were also determined. Best precipitation conditions were obtained at a Cs/Ce–Mo acid ratio of 4 : 1; it yielded a yellow $NH_4 \cdot Cs$ salt of the heteropolyacid. Within a wide range the optical density of the solutions remained proportional with the concentration and thus was useful for colorimetric measurements for time periods up to 24 hours. The precipitate was dissolved in nitric acid and the optical density was determined on a colorimeter with a blue filter. The reagent was found to react also with other long-lived fission products such as $Sr^{90} \rightarrow Y^{90}$, $Ru^{106} \rightarrow Rh^{106}$, and $Ce^{144} \rightarrow Pr^{144}$ and therefore these ele-

ments must be eliminated by precipitation with zirconium and iron hydroxides to obtain radiochemically pure Cs^{137}. A detailed analytical method was developed for separating the other long-lived fission products. (TTT)

11996 ENZYMIC SYNTHESIS OF INOSINE-6-O^{18} FOR INFRARED VIBRATIONAL ASSIGNMENT. Frank B. Howard and H. Todd Miles (National Inst. of Arthritis and Metabolic Diseases, Bethesda, Md.). Biochem. Biophys. Res. Commun., 15: 18-21(Feb. 18, 1964).

Oxygen-18-labeled inosine was synthesized by the adenosine + $D_2O^{18} \xrightarrow{\text{enz.}}$ isosine + NH_3 reaction, and the enzyme kinetics were followed using infrared spectroscopy. Enzymatic deamination of adenosine was observed directly in the infrared cell. The data permit an assignment of 1673 cm^{-1} absorption band to inosine-6-O^{18}. (H.M.G.)

11997 EXPERIMENTAL SENSITIVITY DATA FOR RADIOACTIVATION ANALYSIS WITH 14 Mev NEUTRONS. Yuzuru Kusaka, Haruo Tsuji, and Takayoshi Adachi (Konan Univ., Kobe, Japan). Bull. Chem. Soc. Japan, 36: 1259-61 (Oct. 1963).

Experimental results concerned with the sensitivity of elements for radioactivation analysis with 14-Mev neutrons are described. Data are tabulated. (P.C.H.)

11998 EASIER ANALYSIS WITH NEUTRON ACTIVATION. Can. Chem. Process., 46: 74-5(Feb. 1962).

Neutron activation analysis is described, and neutron generation, sample activation, scintillation counting, pulse-height analysis, and shielding are discussed. (C.E.S.)

11999 DETERMINATION OF GASEOUS OXYGEN IN ANHYDROUS PERCHLORATE CRYSTALS IRRADIATED BY COBALT-60 GAMMA RAYS. L. A. Prince (Stevens Inst. of Tech., Hoboken, N. J.). Chemist-Analyst, 53: 11(Jan. 1964).

The Winkler method for the determination of dissolved oxygen in water was adopted to permit a simple, rapid, and quantitative determination of gaseous oxygen in anhydrous perchlorate crystals of alkali metals and alkaline earths. In the method, Mn(II) sulfate is added in alkaline medium and is oxidized by the oxygen liberated from the dissolved crystals. An excess of iodide is added, the solution acidified, and the iodine formed is titrated with thiosulfate. A correction must be made for other components present that oxidize manganese(II). Results using this method were in excellent agreement with results calculated from radiolytic fragment analyses. (P.C.H.)

12000 ANALYSIS OF THORIUM–LANTHANUM–BARIUM–SILICON–BORON OXIDE OPTICAL GLASS. R. Přibil and V. Veselý (Polarographic Inst., Prague). Chemist-Analyst, 53: 12-13(Jan. 1964).

Methods and reagents for the analysis of Th–La–Ba–Si–B_2O_3 optical glass of declared composition are described. Solution of the glass is readily accomplished with nitric acid and a double evaporation with HCl, which volatilizes most of the boric acid and any traces of Sb or As present. (P.C.H.)

12001 DETERMINATION OF GRAPHITIC CARBON IN URANIUM DICARBIDE. Frank E. Huber and Dan L. Chase (Battelle Memorial Inst., Columbus, Ohio). Chemist-Analyst, 53: 14(Jan. 1964).

It was found that the procedure for determining graphitic carbon in iron or steel can be successfully applied to UC_2 samples if ethyl ether is employed to remove the waxy hydrocarbon residue. A graphitic carbon content in the range of less than 0.01 to more than 1% can be readily determined by the selection of a proper sample size and determination of CO_2. For samples containing more than 1% carbon, a gravimetric method is used; for 0.05 to 1.0% a gasometric procedure; below 0.05% a conductometric technique is used. (P.C.H.)

12002 NEWER APPLICATIONS OF NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY. R. F. Zuercher (CIBA, AG, Basel). Chimia (Aarau), 17: 175-84(June 17, 1963). (In German)

The principles and applications of high-resolution proton magnetic resonance spectroscopy are discussed. A brief discussion of nuclear spin is given, with an outline of experimental technique. The significance and origins of the chemical shift, δ, are mentioned, with emphasis on the influence of electronegative substituents, hybridization changes, magnetic anisotropic effects, and electric field effects; examples of these effects are shown. Spin-spin interactions are discussed with the following examples and patterns: 1,2-dimethyl-5-formylpyrrole, AX; 2,3-dibromothiophenes, AB; 1,1,2-trichloroethane, AX_2; 5-nitroresorcinol, AB_2; 1,1-difluoroethylene, A_2X_2; and naphthalene, A_2B_2. The dependence of the proton-proton coupling constant, $J_{HH'}$ on the H-C-H angle is plotted to demonstrate agreement between theory and experiment; the dependence of J on the dihedral angle of the system H-C-C-H (Karplus equation) is given. Brief mention is made of the utility of double and multiple resonance techniques, with an example from the steroid field. A detailed analysis of the spectrum of 11-acetoxy-9,10-dihydro-9,10-ethanoanthracene is presented. (BBB)

12003 SOLUBILITY OF SULFUR IN HIGHLY PURIFIED IRON. Francois Jamin-Changeart and Simone Talbot-Besnard (Centre National de la Recherche Scientifique, Paris). Compt. Rend., 258: 907-9(Jan. 20, 1964). (In French)

Quantitative analysis by activation (the method is described) revealed a slight solubility of sulfur in highly purified iron that causes important variations in the mechanical properties of the metal. (D.C.W.)

12004 RADIOISOTOPES USED IN PHARMACY. 5. IONIZING RADIATION IN PHARMACEUTICAL ANALYSIS. Knud Kristensen (National Health Service, Copenhagen). Dansk Tidsskr. Farm., 36: 170-83(Sept. 1962). (In Danish)

The use of radioisotope methods for analyzing drugs is reviewed. It is pointed out that heretofore most methods have been based on isotope dilution principles whereas in the future radioactivation analysis, especially with neutron sources, offers great possibilities. (BBB)

12005 A METHOD FOR THE SIMULTANEOUS DETERMINATION OF H^3 AND S^{35} IN SAMPLES WITH VARIABLE QUENCHING. J. K. Weltman and D. W. Talmage (Univ. of Colorado, Denver). Intern. J. Appl. Radiation Isotopes, 14: 541-8(Dec. 1963).

A method is presented for the simultaneous determination of H^3 and S^{35} with a window ratio quench correction. Three channels are used. One window counts H^3 and S^{35}. The other two windows count S^{35} only. The ratio of counts in the S^{35} windows is used to calculate the degree of quenching. H^3 and S^{35} counting rates are then corrected to zero quenching. The standard deviation was less than ±3 per cent of the calculated mean counting rate for each isotope. Methanolic hyamine hydroxide was used as the quenching agent. (auth)

12006 APPLICATION OF ACTIVATION ANALYSIS TO FORENSIC SCIENCE. I. PHYSICAL EVIDENCE. L. C. Bate, J. F. Emery, G. W. Leddicotte, W. S. Lyon,

and M. J. Pro (Oak Ridge National Lab., Tenn.). Intern. J. Appl. Radiation Isotopes, 14: 549-56(Dec. 1963).

Neutron activation analysis was applied to the comparison and identification of a number of physical evidence samples. Specimens of automobile paints, soot, soil, writing ink, and carbon and typewriter print were irradiated with neutrons and studied nondestructively by use of γ-ray spectrometry. Positive comparison and identification was possible in all cases except that of writing ink. (auth)

12007 RADIOACTIVE KRYPTONATES. III. APPLICATIONS. THE MEASUREMENT OF OXYGEN IN THE MARTIAN ATMOSPHERE. D. Chleck and O. Cucchiara (Parametrics Inc., Waltham, Mass.). Intern. J. Appl. Radiation Isotopes, 14: 599-610(Dec. 1963).

Krypton containing the radioisotope Kr^{85} can be stably incorporated into a wide variety of solids. Removal or disturbance of the surface by chemical or physical means causes a proportional loss of activity, rendering these sources useful for numerous applications. An example of such an application is the development of a method for determining the concentration of O_2 in the atmospheres of Mars and Venus. The concentrations of oxygen to be measured were 0.1 per cent by volume at a total pressure ranging from 10 to 100 mm Hg. The method developed is based on the reaction of O_2 with a "kryptonate." This material releases Kr^{85} at a rate proportional to the partial pressure of O_2 in the gas surrounding the material. The O_2 concentration can then be determined by measuring the rate of loss of activity of this material. Two kryptonated materials were investigated—carbon and copper. As little as two ppm of oxygen can be detected by observing the rate of decrease of a kryptonated C source maintained at 1000°C. Oxygen concentrations spanning ten orders of magnitude (10^{-5}–10^5 ppm) can easily be ascertained with kryptonated Cu sources. Ozone can be detected using kryptonated Cu maintained at temperatures less than 300°C. Excellent correlation was obtained with theory and previous published data in regard to reaction kinetics and mechanism. (auth)

12008 LOW-LEVEL COUNTING OF F^{18}. M. Anbar and P. Neta (Weizmann Inst. of Science, Rehovoth, Israel and Soreq Research Establishment, Rehovoth, Israel). Intern. J. Appl. Radiation Isotopes, 14: 623-4(Dec. 1963). (IA-825)

The adequacy of different counting methods for low-level counting of F^{18} is discussed. The performance of scintillation detectors using the coincidence arrangement was compared with that of the single-channel method. It was found that an approximate twofold saving in counting time is achieved using the coincidence system. (P.C.H.)

12009 THE ASSAY OF TRITIUM-LABELLED COMPOUNDS IN FAECES. H. G. Burns and H. I. Glass (Western Regional Hospital Board, Glasgow). Intern. J. Appl. Radiation Isotopes, 14: 627-8(Dec. 1963).

A technique is described for estimating tritium-labeled compounds in human feces using an oxygen-filled bomb colorimeter and liquid scintillation. The method was used to estimate the amount of Betnelan (16-β methyl 9-α fluoropregnisolone) in feces following oral administration. Recovery was found to be 70 percent. Advantages and cost of the technique are discussed. (H.M.G.)

12010 REVISED CURVE FOR SELF-SHIELDING EFFECT IN NEUTRON ACTIVATION. M. Okada (Government Chemical Industrial Research Inst., Tokyo). Intern. J. Appl. Radiation Isotopes, 14: 635(Dec. 1963).

A revised curve, from which the formula $W_{10}\sigma_{abs}/M = 0.08$ was obtained, is presented for the case when an irradiated sample of nearly spherical shape is dissolved before activity measurement and when the self-shielding effect is 10%. It is supposed that if effective absorption cross sections for pile neutrons can be used in the estimation of $W\sigma_{abs}/M$, more accurate curves would be obtained. (P.C.H.)

12011 NON-DISPERSIVE X-RAY SPECTROMETRY, APPLICATIONS TO ELEMENTARY CHEMICAL ANALYSIS. G. Seibel (IRSID. St. Germain-en-laye, France). Intern. J. Appl. Radiation Isotopes, 15: 25-41(Jan. 1964). (In French)

A survey was made of the methods of non-dispersive x-ray spectrometry, which are based on the use of filters and proportional detectors, whose characteristics are compared. Non-dispersive spectrometry can be used in cases where conventional dispersive spectrometry (with an analyzing crystal) is too complicated or too difficult to use: simple x-ray spectrum, very long wavelength x rays and low intensity x-ray sources. Some examples of typical applications are given. 62 references are included. (auth)

12012 ANALYSIS OF RADIOACTIVE COMPOUNDS BY GAS CHROMATOGRAPHY. Arthur Karmen (Johns Hopkins Medical Institutions, Baltimore). J. Assoc. Offic. Agr. Chemists, 47: 15-20(Feb. 1964).

The use of radioactive tracers, analysis of the radioactive compounds by gas chromatography, and measurement of the radioactivity in the effluent of the GLC column represent a powerful combination of techniques that will facilitate the performance of many kinds of studies. The radioactivity can be measured in a number of ways, each of which was studied, and the experimental conditions necessary for successful operation of each were defined. Among other applications, this methodology can be used to study biosynthetic pathways in vivo and in vitro, as in fatty acid synthesis, to study relative rates of metabolism of groups of compounds, to determine traces of specific compounds in complex mixtures, and to calibrate the gas chromatograph. (auth)

12013 METASTABLE IONS IN MASS SPECTROMETRY. G. A. Muccini, W. H. Hamill, and R. Barker (Univ. of Notre Dame, N. J.). J. Phys. Chem., 68: 261-4(Feb. 1964).

The first-order decay constant k_1 was measured for the metastable transition, $C_3H_7^+ \rightarrow C_3H_5^+ + H_2$. For the series from propane to n-decane, k_1 varies from $0.46 \pm 0.24 \times 10^6$ sec^{-1} for n-pentane to $0.72 \pm 0.23 \times 10^6$ sec^{-1} for n-heptane. No trend is apparent. The variation of k_1 with the energy of the ionizing electrons, using n-hexane, increases with decreasing ionizing voltage. The pressure dependence of the diffuse peak at mass number 39.1 shows that the metastable transition is not a collision-induced dissociation. (auth)

12014 A STUDY OF SELECTED IONS IN THE MASS SPECTRA OF BENZENETHIOL AND DEUTERATED BENZENETHIOL. D. G. Earnshaw, G. L. Cook, and G. U. Dinneen (Bureau of Mines, Laramie, Wyo.). J. Phys. Chem., 68: 296-300(Feb. 1964).

Partial mass spectra are presented for benzenethiol, C_6H_5SH, and deuterated benzenethiol, C_6H_5SD. The changes in ion intensities that result from deuterium labeling were studied to determine the structure of the parent ion before fragmentation. A seven-membered ring structure for the parent ion is proposed as precursor for some of the ions studied, whereas the six-membered ring structure for the parent is proposed as precursor for the other ions. Appearance potentials were obtained for several product ions from deuterated benzenethiol, C_6H_5SD, and were used to determine heats of formation of the ions and establish processes by which they are formed. The parent ion is the only intermediate between the molecule, C_6H_5SD, and

the product ions at m/e = 34, 45, 46, 67, 77, 84, 85, and 109. A proposed process for the formation of each of the ions is discussed. When ring cleavage of the parent ion takes place, ring closure in one of the fragments also takes place. (auth)

12015 CONTRIBUTION TO THE SEPARATION OF ALKALI IONS ON CATION EXCHANGERS. II. SEPARATION OF POTASSIUM, RUBIDIUM, AND CESIUM. M. Holzapfel and H. Ehrhardt (Karl Marx Universität, Leipzig). J. Prakt. Chem., 21: 92-8(July 1963). (In German)

Potassium, Rb, and Cs ions (0.5 milliequivalents) were passed through Wofatit KPS cation exchange resin with 3500 ml 2N HF as eluant in polyethylene columns (50 × 1 cm; height of resin, 38.5 cm). The resin contained 16% divinylbenzene and was used in the H form; particle size, 0.1 to 0.5 mm. Potassium and Cs were separated quantitatively in that order; the separation of the other pairs was not quantitative but the method appears applicable to the preparation of their fluorides. HCl (2N) eluted all 3 alkali ions quickly without separation; 2N formic acid did not elute the ions at all. Results were interpreted in terms of the low dissociation constant of HF and the formation of complex ions $M(HF)_n^+$. (BBB)

12016 ROENTGENOFLUORESCENCE ANALYSIS BY RADIOACTIVE X-RAY SOURCES AND GAMMA-RAY SCINTILLATION SPECTROMETERS. L. Górski. Kernenergie, 6: 710-13(Dec. 1963). (In German)

On account of the great apparatus requirements and the high costs, which are required by classical roentgen fluorescence analysis apparatus that work according to the Bragg principle, an experiment was undertaken to carry out roentgen fluorescence analysis with the help of gamma-scintillation spectrometers for spectrometric identification of x rays during use of radionuclides for excitation of fluorescence radiation, which means with essentially simple and ordinary means. (tr-auth)

12017 MASS-SPECTROMETRIC ISOTOPE ANALYSIS OF NITROGEN FROM EARTH GASES AND ROCKS. J. Pilot (Institut für Mineralogie und Lagerstättenlehre der Bergakademie, Freiberg i. B.). Kernenergie, 6: 714-17(Dec. 1963). (In German)

Nitrogen from marsh gas was purified in a circulation system and the isotope ratio determined. The nitrogen from rocks was obtained by heat extraction, purified, and its isotope ratio also measured for comparison. A control of the purity of the gases showed that it affects the isotope determination with an error of < 1.5%. (tr-auth)

12018 MEASUREMENT OF RADON IN SOIL GAS. K. G. Vohra, M. C. Subbaramu, and A. M. Mohan Rao (Atomic Energy Establishment, Trombay, India). Nature, 201: 37-9(Jan. 4, 1964).

Using the method developed for radon measurement in soil gas, the vertical profile of radon concentration in the upper 1 m of soil was investigated. Radon is estimated from the beta activity of daughter products collected on a filter paper from a stored sample containing radon in equilibrium with its daughter products. (M.C.G.)

12019 RE-ACTIVATION ANALYSIS OF MAGNESIUM. Yuichiro Kamemoto and Shigeru Yamagishi (Japan Atomic Energy Research Inst., Tokyo). Nature, 201: 65-6(Jan. 4, 1964).

Determination of magnesium by re-activation analysis is described. The magnesium-containing solution was irradiated in a neutron flux of 3×10^{11} n/cm^2/sec for 6 min. Magnesium was then extracted in a benzene solution and the activity counted. After the Mg^{27} was allowed to decay to a negligible amount, the benzene solution of magnesium was irradiated again for 3 min and the gamma spectra were then measured. The amount of magnesium in the unknown sample was calculated by the following equation:

$$W = \frac{\text{Asam.} \times \text{Wc.} \times \text{Wst.}}{\frac{\text{Ast.} \times \text{Asam.} \times \text{Wst.}}{\text{Ast.}} - \text{Asam.} \times \text{Wst.}}$$

where W is weight of Mg in sample, Ast. is induced activity of Mg^{27}, Wst. is weight of standard Mg, Asam. is activity of Mg^{27} isolated from first irradiation sample, Wc. is weight of Mg carrier added to irradiated sample, and Asam. is the induced activity of Mg^{27} from the second irradiation. (M.C.G.)

12020 ACTIVATION ANALYSIS AS A TOOL FOR INDUSTRY AND RESEARCH. S. E. van den Broek. Nucl. Energy, 36-8(Feb. 1964).

Recent developments in neutron activation analysis are reviewed. Applications are discussed, and the Universal Activation Reactor-10, especially designed for neutron activation analyses, is described. (R.E.U.)

12021 BETA RAY GAUGING TECHNIQUE FOR MEASURING LEAD WATER CONTENT CHANGES AND MOISTURE STATUS OF PLANTS. F. S. Nakayama and W. L. Ehrler (Dept. of Agriculture, Tempe, Ariz.). Plant Physiol., 39: 95-8(Jan. 1964).

The beta ray gaging technique for determining leaf water content and internal water status of plants was investigated. Promethium-147 was shown to provide beta rays of the right energy to give the best response to water changes in the cotton leaves with thicknesses of 15 to 35 mg cm^{-2}. Equipment construction and gauge performance were checked using a 2 μC promethium-147 source on plants under controlled environmental conditions. The instrument showed reliable responses to rapid change in water conditions of plants. With proper calibrations, leaf water and internal water (relative turgidity or diffusion pressure deficit) changes can be followed. (auth)

12022 IDENTIFICATION OF THE NATURE OF THE CONSTITUENTS OF A SUBSTANCE BY SPECTRUM ANALYSIS WITH X RAY FLUORESCENCE. F. Lafay. Presse Med., 70: 45-8(Jan. 6, 1962). (In French)

A review of the fundamentals of x-ray fluorescence spectroscopy is presented. The principles of the method are discussed, and the principal K and L radiation bands of Al, Cr, Cu, Zr, Nd, W, and U are tabulated; comparison is made with optical spectra. A schematic diagram illustrates the usual instrumentation for x-ray fluorescence. A discussion of the properties desirable in the emitter tube includes anode material (W, Mo, Au), and the importance of maintaining steady emission intensity is given. Collimation of sample emission and focusing of emission from samples of small dimensions is considered. The same detectors are useful as in radiocrystallography; the best detector is a scintillation counter, with NaI as scintillation crystal. This has the proper sensitivity in the appropriate spectral region. A table of instrumental data for different wavelength ranges is given. The increasing use of the gaseous flux counter is mentioned. A number of analyzer crystals are tabulated: LiF, SiO_2, NaCl, CaF_2, Al, Si, mica; their regions of usefulness are mentioned briefly. The preparation of samples in the solid, liquid, and gaseous states is touched upon; in particular, the utility of the method in giving rapid determinations of the concentrations of Fe, Ca, and Br in blood and other body fluids is stressed. (BBB)

12023 MÖSSBAUER EFFECT IN HEMOGLOBIN WITH DIFFERENT LIGANDS. U. Gonser (North American Aviation Science Center, Canoga Park, Calif.), R. W. Grant, and J. Kregzde. Science, 143: 680-1(Feb. 14, 1964).

Recoil-free nuclear gamma resonance adsorption was observed in the iron-57 of blood. The spectral parameters are dependent on the ligand bound to the iron atoms in hemoglobin. The results are interpreted in terms of isomeric shifts and quadrupole splittings. (auth)

12024 GEOMETRY-RELATED ERRORS IN INSTRUMENTAL NEUTRON-ACTIVATION ANALYSIS. Ralph A. Johnson (Shell Development Co., Emeryville, Calif.). Talanta, 11: 149-58(Feb. 1964).

Geometry-related errors in instrumental neutron-activation analysis are defined and evaluated. Neutron-flux distributions, variations in counting geometry, and intra-sample neutron moderation and reflection are discussed in relation to these errors. Devices for error control are described. (auth)

12025 RADIOCHEMICAL DETERMINATION OF STRONTIUM-89 AND -90 IN URANIUM MINERALS AND SALTS. P. K. Kuroda and Hirofumi Arino (Univ. of Arkansas, Fayetteville). Talanta, 11: 343-9(Feb. 1964).

A combination of low-level counting technique and large-scale analytical operation was employed to determine extremely small quantities of strontium-89 and -90 in uranium ores and salts. Strontium carrier is added to a kilogram quantity of the samples of non-irradiated uranium ore and salt, exhaustively purified, and counted. The levels of radiostrontium found are of the order of 10^{-4} disintegrations/sec^{-1}/g^{-1} of uranium in the sample. The strontium isotopes are formed in non-irradiated uranium salts and ores predominantly by the spontaneous fission of uranium, but neutron-induced fission of uranium-235 also appears to occur in the latter. (auth)

12026 COUMARIN DERIVATIVES FOR MEDICINAL PURPOSES. XV. SYNTHESIS OF 6-CHLOROCOUMARIN-Cl^{36} AND ITS DISTRIBUTION IN VIVO. Haruo Kitagawa (National Heart Inst., Bethesda, Md.), Riitiro Iwaki, and Teruhisa Noguti. Yakugaku Zasshi, 83: 861-5(Sept. 1963). (In Japanese)

Methods are outlined for the synthesis of Cl^{36}-labeled-6-chlorocoumarin-Cl^{36} by modified diazotization from 6-aminocoumarin hydrochloride-Cl^{36}. Diazotization was carried out with sodium nitrite and 3N hydrochloric acid in ether or with isoamyl nitrite in dioxane. The diazonium chloride-Cl^{36} formed was decomposed in ether (with addition of hydrogen chloride gas) or with copper powder in acetone. The product had an activity of 3.2×10^5 cpm/millimole. Oral administration of 6-chlorocoumarin-Cl^{36} to a rabbit resulted in decrease of urine on the 2nd and 3rd day but the amount of urine returned to normal on the 4th day. Radioactivity decreased progressively irrespective of urinary excretion and 22.8% of the original radioactivity was found in the urine excreted during 96 hr after administration. 6-Chlorocoumarin-Cl^{36} was distributed in various organs and the incorporation ratio per gram of the organ decreased in the order: small intestine, kidney, pancreas, spleen, skeletal muscle, heart, bladder, and brain. Incorporation ratio to total weight of organs decreased in the order: kidney, pancreas, liver, heart, spleen, and brain. (BBB)

12027 TRACE ANALYSIS OF BORON IN NUCLEAR GRAPHITE BY MEANS OF GAS CHROMATOGRAPHY. F. Zado (Institut "Rudjer Boskovic," Zagreb). p.49-55 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. II." Vienna, International Atomic Energy Agency, 1963.

No literature is available about the application of gas chromatography in trace analysis of boron in graphite. The following methods of transformation of boron into its volatile compounds are discussed. (a) Ignition of graphite in a stream of oxygen and subsequent transformation of boron oxide into volatile methyl borate which is then analyzed on a Dilkens Aerograph H Model 96 gas chromatograph with silicone column and hydrogen as carrier (concentration method). (b) Extraction of boron from the graphite by means of sodium fluoride at 2800°C with simultaneous chlorination and trapping of boron trichloride, which is then analyzed (direct method). A home-made gas chromatograph with a thermal conductivity detector and nitrogen as a carrier was used. The column was made of glass with a 20% (wt./wt.) fluorocarbon oil on kieselguhr. Special precautions were taken on account of the sensitivity of boron trichloride to moisture. (auth)

12028 INSTRUMENTAL ACTIVATION ANALYSIS FOR IDENTIFICATION OF FORENSIC SPECIMENS. R. E. Jervis (Univ. of Toronto). 24p. (CONF-313-8)

From 2nd National Meeting of the Society for Applied Spectroscopy, San Diego, Calif., Oct. 1963.

Experimental results are presented for comparison of inorganic materials such as glass fragments and metals and biological materials such as human hair and tissues by instrumental activation analysis. Comparison tests were devised using a series of photopeak ratios calculated from experimental peak heights, rather than using absolute peak intensities. This procedure, in effect, makes use of an internal reference standard as a basis of normalizing all relative nuclide concentrations, and thereby eliminates variations in absolute concentrations resulting from variable moisture content of organic materials, tissue specimens, soils, or dilution by innocuous foreign matter. The statistical significance of empirical comparisons is discussed. (P.C.H.)

12029 IMPROVEMENTS IN OR RELATING TO A METHOD OF TESTING FOR LEAD-210. Brian Arthur Loveridge and William Malcolm Henry (to United Kingdom Atomic Energy Authority). British Patent 949,102. Feb. 12, 1964. Filed Oct. 3, 1961.

The detection and measurement of Pb^{210} in effluents is discussed. The process comprises precipitating the lead as sulfate along with any strontium present, dissolving the lead content as chloride, and effecting an ion-exchange separation from contaminants. After a 5-day delay, the beta particles from Bi^{210} are counted with provision for stopping any beta particles from Pb^{210} and alpha particles from Po^{210}. (R.E.U.)

Inorganic and Physical Chemistry

12030 (AD-427205) ON THE QUESTION OF ISOTOPIC PHASE SEPARATION IN SOLID H_2-D_2 MIXTURES. Technical Report No. 10. J. R. Gaines, E. M. de Castro, and J. B. Daunt (Ohio State Univ. Research Foundation, Columbus). Dec. 1963. Contract N6onr-495(20). 10p.

Possible isotopic phase separation in solid H_2-D_2 mixtures were investigated by observations of nuclear resonance line widths and shapes. No composite resonance line was found at 16.4 to 3°K, but at temperatures below 3°K, composite lines were observed. The transition from a single line at > 3°K to a composite line shape was found

to occur relatively quickly. The results could be interpreted as due to isotopic phase separation, but there is not quite sufficient evidence for this interpretation. (D.L.C.)

12031 (AEET/CD/18) STUDIES ON THE PREPARATION OF ALUMINIUM NITRIDE. I. A. Khan, T. R. Bhat, and N. S. Krishna Prasad (India. Atomic Energy Establishment, Trombay). 1963. 17p.

The reaction between aluminium and nitrogen was investigated in detail using NaF, KHF_2, MgF_2, CaF_2, PbF_2, BiF_3, AlF_3, and CeF_3 as catalysts. The optimum conditions for the formation of aluminium nitride were found to be: Catalyst = 5% KHF_2, temperature = 1000°C, and heating time = 3 hours. Under these conditions, the product contained 94 to 96% of aluminium nitride. A method is also described for the preparation of aluminium nitride of low carbon content. (auth)

12032 (ANL-6803) COMPOUNDS IN THE BINARY PHASE DIAGRAMS OF THE MONOVALENT CHLORIDES WITH THE MULTIVALENT CHLORIDES. R. Gut, E. Iberson, and D. M. Gruen (Argonne National Lab., Ill.). Nov. 1963. Contract W-31-109-eng-38. 21p.

The phase-diagram literature was surveyed to the end of 1960. Information about the binary systems of monovalent with multivalent chlorides was observed. Compounds of double chlorides occurring in these systems are listed in tabular form together with the available structural information. (auth)

12033 (ATN-64(9236)-3) DIRECT HIGH-TEMPERATURE SINGLE-CRYSTAL OBSERVATION OF ORIENTATION RELATIONSHIP IN ZIRCONIA PHASE TRANSFORMATION. G. M. Wolten (Aerospace Corp., El Segundo, Calif.). Sept. 4, 1963. 12p.

Work was undertaken to examine the validity of predictions concerning behavior of forward and reverse transformations of ZrO_2 single crystals from monoclinic structure to tetragonal structure. Single crystals of zirconia were attached to an insulator, oriented in a diffractometer, and heated through the transformation. Axial relations were observed for both the forward and reverse transformations. (auth)

12034 (CONF-385-1) PROGRESS IN THE CALORIMETRY AND THERMODYNAMICS OF PHASE AND ORDERING TRANSITIONS. Edgar F. Westrum, Jr. (Michigan. Univ., Ann Arbor. Dept. of Chemistry). [1963]. Contract AT(11-1)-1149. 85p.

From IUPAC Symposium on Thermodynamics and Thermochemistry, Lund, Sweden, July 1963.

Some general aspects of the nature and types of transitions, their classification, their mechanisms, and some experimental problems in their study are discussed. Topics covered include: theory of transitions, experimental aspects, molecular disorder and globular molecules, determination of barrier heights, rotation of anions in inorganic lattices, absorbed films, transitions in metals, transitional studies at elevated temperatures, and ordering transitions in organic compounds. One hundred and forty-two references are included. (M.C.G.)

12035 (HW-79350) OXIDATION OF A NICKEL–2% ThO_2 ALLOY AND THE LOGARITHMIC RATE LAW OF OXIDATION. D. A. Jones and R. E. Westerman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1963. Contract AT(45-1)-1350. 35p.

The oxidation of pure nickel containing a dispersion of submicron size ThO_2 particles was investigated in the range 600 to 1000°C. At 600 and 700°C, oxidation was described by a parabolic equation. At 950 and 1000°C, a mixed parabolic relationship (partial control by an interface reaction) applied. Logarithmic oxidation, concurrent with a minimum in the oxidation rate, occurred at intermediate temperatures of 800, 850, and 900°C. The partially controlling interface reaction at 950 and 1000°C is interpreted to be activated adsorption of oxygen at the oxygen-oxide interface. A logarithmic rate law for oxide film formation is derived by considering oxygen adsorption as the controlling process. Application of this theory is discussed with respect to the present work on nickel and previous work on the formation of thin oxide films on metals. (auth)

12036 (NOLC-585) PREPARATION OF THE SYNTHETIC STRONTIUM ISOMORPH OF COLEMANITE AND OTHER RELATED STRONTIUM BORATE HYDRATES. C. R. Parkerson (Naval Ordnance Lab., Corona, Calif.). June 1, 1963. 29p. (AD-411490)

The chemistry of the strontium borates has been studied, and a new ferroelectric strontium borate hydrate ($2\,SrO \cdot 3\,BeO_3 \cdot 5\,H_2O$) has been synthesized. This compound is the strontium isomorph of colemanite ($2\,CaO \cdot 3\,B_2O_3 \cdot 5\,H_2O$). The following series of reactions were investigated: (1) reactions of borax and strontium iodate, (2) miscellaneous conversion reactions in borax and boric acid solution, (3) reactions of ammonium pentaborate and strontium nitrate, and (4) reactions of ammonium pentaborate and strontium iodate. Five compounds produced by the above reactions were: compound I ($2\,SrO \cdot 3\,B_2O_3 \cdot 5\,H_2O$), compound II ($SrO \cdot I_2O_5 \cdot O \cdot 5\,H_2O$), compound III ($SrO \cdot 3\,B_2O_3 \cdot 4\,H_2O$), compound IV ($SrO \cdot 3\,B_2O_3 \cdot 4\,H_2O$), compound V ($SrO \cdot B_2O_3 \cdot 4\,H_2O$). Compound VI ($SrO \cdot B_2O_3 \cdot 4\,H_2O$) was prepared by other methods. Compound III is dimorphous with compound IV; compound V is dimorphous with compound VI. (auth)

12037 (NP-13622) THERMODYNAMIC PROPERTIES OF 65 ELEMENTS—THEIR OXIDES, HALIDES, CARBIDES, AND NITRIDES. Bulletin 605. Charles E. Wicks and F. E. Block (Bureau of Mines. Albany Metallurgy Research Center, Ore.). Dec. 1961. 150p.

A compilation is presented of the heat contents, heats of formation, free energies of formation, and other thermodynamic parameters for 65 common elements and their respective oxides, halides, carbides, and nitrides. The data were obtained from the literature published through 1959 and should be valuable in the metallurgical field. (D.L.C.)

12038 (ORNL-3544) REDUCTION OF URANIUM HEXAFLUORIDE RETENTION ON BEDS OF MAGNESIUM FLUORIDE USED FOR REMOVAL OF TECHNETIUM HEXAFLUORIDE. Sidney Katz (Oak Ridge National Lab., Tenn.). Jan. 31, 1964. Contract W-7405-eng-26. 11p.

The excessive loss of uranium incurred when discarding magnesium fluoride, (the adsorber used to selectively remove technetium hexafluoride from uranium hexafluoride streams) is a problem common to all volatility processes for recovering enriched uranium fuels. As a result of the work described, two schemes for the release of the uranium hexafluoride from the magnesium fluoride and its separation from the technetium hexafluoride are proposed. One scheme depends on preferential thermal desorption of the uranium hexafluoride at 350°C and the other on selective adsorption of the uranium hexafluoride on sodium fluoride pellets following the codesorption of the two hexafluorides with fluorine at 500°C from the magnesium fluoride pellets. These proposals are aimed at reducing the

amount of retained uranium to less than 1 g per 1000 g of discardable magnesium fluoride. In the work reported, the deposition of uranium on magnesium fluoride as a function of heating, fluorination, and hydrogen fluoride pretreatment of the magnesium fluoride pellets prior to exposure to uranium hexafluoride was characterized in a series of gasometric studies. The dependence of the quantity of uranium hexafluoride adsorbed on pressure and temperature was also determined. The data show that physical adsorption is the mechanism for the deposition of most of the uranium hexafluoride on well-stabilized magnesium fluoride pellets. More than 90% of the adsorbate can be removed by heating to 350°C. Chemisorption (formation of a double salt) is probably not involved because of the small (<0.05) mole ratio of UF_6/MgF_2 observed. (auth)

12039 (PWA-1921) THERMODYNAMIC PROPERTIES OF IONIZED AND DISSOCIATED AIR FROM 1500°K TO 15,000°K. F. Landis and E. N. Nilson (Pratt and Whitney Aircraft Div., United Aircraft Corp., Hartford, Conn.). Jan. 1961. 112p.

Tables are presented listing the thermodynamic properties of dissociated and ionized air from 1,500°K to 15,000°K. In addition to the basic state variables, such as temperature, density, pressure, enthalpy, and entropy, the tables also list electron concentration and differentiated properties including specific heats, specific heat ratio, isentropic expansion coefficient, and sound velocity. These differentiated properties have been obtained by a novel direct numerical interpolation and differentiation technique, the so-called "spline fit," which is described in detail. (auth)

12040 (SSD-TDR-63-99) CALCULATION OF RATE COEFFICIENTS FOR SOME ELEMENTARY REACTIONS. I. HYDROGEN, DEUTERIUM, AND DEUTERIUM HYDRIDE WITH CHLORIDE. Roger L. Wilkins (Aerospace Corp., El Segundo, Calif.). May 15, 1963. Contract AF04-695-169. 28p. (AD-407555)

Rate coefficients were calculated for the reactions of hydrogen, deuterium, and deuterium hydride with chlorine. The potential energy surfaces of the isotopic transition complexes of HCl_2 and H_2Cl were constructed by the Sato method to match experimental activation energies in accordance with absolute rate theory. The rate coefficients calculated using absolute rate theory are then used to evaluate the relative rates of reaction of H_2/HD, H_2/D_2 with chlorine atoms, and the relative rates of the fast reaction step $H + Cl_2$ compared to the back reaction H + HCl. The results agree very well with the few experimental values reported in the literature. Theoretical calculations show that prior experimental values of the preexponential factors in the Arrhenius-type expression for rate constants are not required in order to obtain better information on the structure and vibrational frequencies of the transition states. Agreement of the activated complex theory with experiment was satisfactory. (auth)

12041 (TID-19489) HIGH TEMPERATURE OXIDATION AND NITRIDATION OF NIOBIUM IN ULTRAHIGH VACUUM. Interim Report, June 1, 1962 to July 1, 1963. R. A. Pasternak (Stanford Research Inst., Menlo Park, Calif.). Contract AT(04-3)-115. 51p.

New techniques and methods were developed for the study of sorption mechanisms and gas-metal equilibria at very low pressures and over a wide range of temperatures. A theoretical treatment of possible sorption mechanisms has been carried out. The sorption of nitrogen by three niobium samples was studied over a wide temperature and pressure range. Sorption by two of the samples showed the same pattern: formation of a monolayer at room temperature; growth of a nitride layer at intermediate temperatures; and at high temperatures solution of nitrogen in the metal at a rate which is independent of time t and temperature T but proportional to pressure p. Since the sorption efficiency for the two samples was about the same, one can express the concentration C of gas in the sample of mass m and area A as $C = 1.8 \times 10^3 (A/m)pt$ (ppm). If a generalization is justified, this expression is approximately valid for temperatures above 500 to 700° and pressures below 10^{-5} torr, and for concentrations significantly smaller than that at saturation. Some sorption data were obtained with the third sample for nitrogen and for oxygen. This sample showed very little activity for nitrogen; it is suspected that surface and/or bulk contamination of an unknown nature are responsible. (auth)

12042 (TID-20114) ELECTROCHEMISTRY, THERMOCHEMISTRY AND FUSED SALTS. Annual Progress Report, January 1, 1963–December 31, 1963. Joseph Jordan (Pennsylvania State Univ., University Park. Coll. of Chemistry and Physics). Jan. 20, 1964. Contract AT(30-1)-2133. 9p.

Electron transfer and acid-base chemistry in molten nitrate and chloride environments is being studied. The foundation of a "Lux-Flood base-strength scale" was laid, based on oxide donor-acceptor properties in fused salts. Polarography and thermometric titrations were used cooperatively to clarify the endothermic oxidation of Cr(III) to Cr(IV) in a chloride solvent at 400°C. Model studies in aqueous solutions were carried out on the thermochemistry of inert ion pair complexes and on the electrochemistry of a divalent thallium species. An advanced version of the Kelly–Fisher controlled-potential polarograph was constructed. Two single-crystal silver electrodes were prepared. (M.C.G.)

12043 (TID-20147) THE ACCELERATION OF THE URANIUM(IV)-(VI) EXCHANGE REACTION BY TARTARIC ACID. E. Phillip Benson, Jr. and Carl H. Brubaker, Jr. (Michigan State Univ., East Lansing. Kedzie Chemical Lab.). [1961]. Contract AT(11-1)-1001. 14p.

The effects of several organic acids on the exchange reaction between uranium(IV) and uranium(VI) was studied in perchloric acid-sodium perchlorate solutions of ionic strength = 2.0 M. All of the acids were found to accelerate the reaction with the effect decreasing in the order tartaric ≫ malic > maleic > malonic. The exchange rate, in the presence of tartaric acid, was found to fit the rate law

$$R = \frac{k_1[U^{4+}]^2[UO_2^{2+}]}{[H^+]^4} + \frac{k_2[U^{4+}][H_2Tar]}{[H^+]^2} + \frac{k_3[U^{4+}][H_2Tar][UO_2^{2+}]}{[H^+]^2}.$$

(auth)

12044 (TID-20174) THE HIGH TEMPERATURE VAPORIZATION PROPERTIES OF BORON CARBIDE AND THE HEAT OF SUBLIMATION OF BORON. Harry E. Robson and Paul W. Gilles (Kansas. Univ., Lawrence). [1964]. Contract AT(11-1)-114. 17p.

The vaporization behavior of boron carbide solid solutions is shown to be the preferential loss of gaseous boron regardless of the sample composition. An invariant system consisting of a graphite crucible and a carbon-saturated boron carbide sample was used to measure the vapor pressure over the temperature range 2184 to 2522°K. The Knudsen technique employing condensation targets was used, and boron was specifically assayed by a coulometric titration of the mannitol complex. The derived third law heats of

sublimation in kcal per mole of boron are $\Delta H_0^\circ = 136.8 \pm 0.1$ and $\Delta H_{298}^\circ = 138.0 \pm 0.1$ for boron carbide and $\Delta H_0^\circ = 133.8 \pm 0.7$ and $\Delta H_{298}^\circ = 135.0 \pm 0.7$ for boron. (auth)

12045 (JPRS-23361) RHENIUM. K. B. Lebedev. Translation of p.1-208 from "Reniy" (a publication of Metallurgizdat, Moscow, 1963). 250p. (OTS-64-21632)

This book presents information on the properties, applications, sources, production methods, and analytical chemistry of rhenium. Emphasis is placed on the problems of industrial production of rhenium from raw materials. (D.L.C.)

12046 THE STABILIZATION OF OXIDATION STATES OF THE TRANSITION METALS. R. S. Nyholm and M. L. Tobe (University Coll., London). Advan. Inorg. Chem. Radiochem., 5: 1-40(1963).

The ways in which chemical environment may stabilize a particular oxidation state are discussed and an attempt was made to rationalize the dependence of the oxidation state on the various electronic promotion energies of the transition metal atom or ion and the pertinent properties of the chemical environment. The fundamental controlling factor for the oxidation state adopted by transition metal in a compound appeared to be the stability of an electrically neutral situation around the metal and indeed around every atom in the system. Although it was not possible to convert this principle of electroneutrality to a quantitative basis, it remained a working hypothesis with which to assess the stability of a particular compound. The major departure from this principle occurred in ionic lattice compounds where the loss of stability due to the departure from electroneutrality was more than compensated by the gain in lattice energy. In these compounds the major factors influencing the stability of an oxidation state were the relevant ionization potentials of the metal and the lattice energy of the product and, to a lesser extent, the appropriate electron affinities of the nonmetallic component. (M.C.G.)

12047 URANATES OF THE TYPE MeU_3O_{10}. Cesare Brisi (Politecnico, Turin). Ann. Chim. (Rome), 53: 325-32(Apr. 1963). (In Italian)

Four new compounds were prepared: NiU_3O_{10}, CoU_3O_{10}, MnU_3O_{10}, and CuU_3O_{10}. They were synthesized by two methods. The equivalent amount of U_3O_8 was heated with NiO, Mn_2O_3, Co_3O_4, or CuO in air to 700-800°C. Alternately aqueous solutions of the nitrates of Ni, Mn, Co, and Cu and $UO_2(NO_3)_2$ were evaporated to dryness and the residues calcined. Better results were obtained by the second method. The CuKα spectrograms of the compounds are tabulated. The crystal structures are all similar, having a pseudohexagonal cell with the constants: NiU_3O_{10}, $a_0 = 3.78$Å, $c_0 = 4.04$Å; MnU_3O_{10}, $a_0 = 3.79$Å, $c_0 = 4.14$Å; CoU_3O_{10}, $a_0 = 3.79$Å, $c_0 = 4.08$Å; CuU_3O_{10}, $a_0 = 3.77$Å, $c_0 = 4.17$Å. NiU_3O_{10} decomposes at ~960°C to give NiO and U_3O_8; CoU_3O_{10} at ~940°C to give $CoUO_4$ and U_3O_8; MnU_3O_{10} at ~1000°C to give $MnUO_4$ and U_3O_8; and CuU_3O_{10} at 910°C to give U_3O_8 and probably $CuUO_4$, which decomposes further at this temperature. When MnU_3O_{10} is heated in air at 1250°C for 5 or 25 hr, $MnU_3O_{8.5}$ is obtained. This has a fluorite structure, a_0 5.308Å. Under the same conditions a mixture of MnU_3O_{10} and $MnUO_4$ with U/Mn equal to 5/3 yields a similar fluorite structure, $Mn_3U_5O_{16.5}$, $a_0 = 5.288$Å. A large zone of solid solutions with the fluorite structure may therefore be possible for the system Mn-U-O. Small amounts of similar compounds were obtained by heating mixtures of $MnUO_4$ and $MnCO_3$ (Mn/U ratio slightly >2) to 1250°C in air. These had a fluorite structure. (BBB)

12048 THE SYSTEM BETWEEN THE PYROPHOSPHATES OF URANIUM AND THORIUM. Aurelio Burdese and Maria Lucco Borlera (Politecnico, Turin). Ann. Chim. (Rome), 53: 333-42(Apr. 1963). (In Italian)

Both ThP_2O_7 and UP_2O_7 exist in cubic and rhombic forms. Rhombic ThP_2O_7 (β) is stable from 810 to 1290°C; above and below this range the cubic (α) form is stable. Dilatometric and crystallographic data indicated another transformation between α and α' modifications at 98°C, which is accompanied by a linear contraction of 0.2%; the cell constant (a_0) changes sharply from 8.722 Å to 8.740 Å in the interval from 80 to 100°. Above 1300°C, P_2O_5 volatilizes from ThP_2O_7 noticeably and the orthophosphate is formed at an appreciable rate. Below 460°C rhombic (β) UP_2O_7 is stable; above this temperature, α. Dilatometric and crystallographic measurements and differential thermal analysis pointed to the α form above about 325°, and α' form stable in the range 325 to 120°, and an α'' form at ordinary temperatures. Tables of the powder spectrograms (CuKα) for both forms of ThP_2O_7 and UP_2O_7 are given. A phase diagram of the system between 700 and 1300° is presented. A closed β region which contains maximum U (20%) at 1000°C, a two-phase region (maximum U, 33%, 1050°), and a single solid solution (α) were found. The lattice constant of this last phase was a linear function of the composition. (BBB)

12049 SYSTEMS BETWEEN PHOSPHORIC ANHYDRIDE AND THE DIOXIDES OF URANIUM AND THORIUM. Aurelio Burdese and Maria Lucco Borlera (Politecnico, Turin). Ann. Chim. (Rome), 53: 344-55(Apr. 1963). (In Italian)

In both the $UO_2-P_2O_5$ and $ThO_2-P_2O_5$ systems 5 compounds were found with the ratio $MO_2 : P_2O_5$ equal to 0.5, 1, 1.5, 2, and 3. The corresponding orthophosphates are isomorphic and completely soluble in the solid state, as are the metaphosphates; above 1000°C the metaphosphates form pyrophosphates, losing P_2O_5. The cubic and rhombic forms of the pyrophosphates are isomorphic, but their regions of stability correspond to different temperature intervals and the relative solubility of the rhombic pyrophosphates in the solid state is therefore low. Compounds with high ratios of metal oxide to P_2O_5 are stable only at high temperatures: $(UO)_2P_2O_7$ is formed above 900°C; $(ThO)_2P_2O_7$ above 1350; $(UO)_3(PO_4)_2$ above 1200; $(ThO)_3(PO_4)_2$ above 1150°C. Both of these pairs have low reciprocal solubility and are not isomorphic. Tentative phase diagrams are illustrated. (BBB)

12050 THERMAL CONDUCTIVITY OF BERYLLIUM OXIDE IN THE RANGE FROM 1000 TO 2000°C. A. G. Kharlamov. At. Energ. (USSR), 15: 517-19(Dec. 1963). (In Russian)

In previous studies on the thermal conductivity of dense BeO it was assumed that this property passes through a minimum at around 1700°C. The previously described stationary method (Teploenergetika No. 3, 64 (1961)) was used to determine the heat conductivity of this material between 1000 and 2000°C. The cylindrical specimens were heated internally by means of a W rod and the temperature measured by means of chromel-alumel thermocouples and at high temperatures by Ir-Rh thermocouples. The experimental error was estimated at about 10%. The dependence of the thermal conductivity on the temperature in the range from 1000 to 2000°C may be expressed analytically by the formula $\lambda = (2.05 \times 10^4/T - 273) + 9 \times 10^{-14}\, T^3\, e^{3.74 \times 10^{-3} T}$ kcal m hr°C, where T is given in °K. A very flat minimum was found in the curve between 1600 and 1800°C; the increase started at 1700 and at 2000°C it reached a value 17% over the minimum. The role of the absorption coeffi-

cient on the course of the function was also examined. (TTT)

12051 THE LOW-TEMPERATURE HEAT CAPACITIES OF NONSTOICHIOMETRIC NIOBIUM HYDRIDE. HYDROGEN FREQUENCIES IN METAL HYDRIDES. Z. Bieganski and B. Staliński (Technical Univ., Wroclaw, Poland). Bull. Acad. Polon. Sci., Ser. Sci., Chim., 10: 579-82(1963).

The heat capacities of niobium hydride, $NbH_{0.883}$, were measured at 21 to 386°K. The weight of the sample used was 47.70 g. The heat capacities of the hydride in the low-temperature range were much smaller than those of the metal. At temperatures above 300°K a continuous and rapid increase of the heat capacity was observed. (P.C.H.)

12052 THE CHROMIC ACID OXIDATION OF ARYL TRIFLUOROMETHYL ALCOHOLS: ISOTOPE AND SUBSTITUENT EFFECTS. Ross Stewart and Donald G. Lee (Univ. of British Columbia, Vancouver). Can. J. Chem., 42: 439-46(Feb. 1964).

The mechanism of chromic acid oxidation of eight aryltrifluoromethylcarbinols was studied in acetic acid solution. Electron-donating substituents accelerate the reaction and a good correlation of rate with σ^+ values was found. The rho value is −1.01. Deuterium isotope effects for the oxidation of five of the compounds were determined and the magnitude of the isotope effect was found to correlate inversely with the ease of oxidation of the alcohol. The results are interpreted in terms of a unimolecular decomposition of the chromate ester of the alcohol. (auth)

12053 NUCLEAR SPIN RELAXATION IN GASES AND LIQUIDS. III. MOMENTUM-DEPENDENT INTERACTIONS. I. Oppenheim (Massachusetts Inst. of Tech., Cambridge), M. Bloom, and H. C. Torrey. Can. J. Phys., 42: 70-83 (Jan. 1964).

A momentum-dependent interaction was used by Torrey to explain the Xe^{129} nuclear spin relaxation measurements of Carr and co-workers. T_1 is calculated for this interaction for gases and liquids using the constant-acceleration approximation. The gas results are in good agreement with Torrey's exact calculation for a gas of hard spheres and have the advantage of being usable with more realistic interatomic potentials. The results for the liquid are in good agreement with experiment. (auth)

12054 ORDER OF THE AIR–GRAPHITE (500°C) AND CO_2–GRAPHITE (620-670°C) REACTIONS BETWEEN PRESSURES OF 1 ATMOSPHERE TO 18 BARS. Francois-Michel Lang and Pierre Magnier (CEA, Saclay, France). Compt. Rend., 258: 889-91(Jan. 20, 1964). (In French)

The reactions of air and purified CO_2 with highly purified nuclear graphite at 500 and 650°C and 620–670°C, respectively, under pressures of 0–18 bars were studied. The order of the air–graphite reaction depends on the pressure and the porosity, while the order of the CO_2 reaction remains near zero. (D.C.W.)

12055 THE HEAT CAPACITY C_v OF WATER AND STEAM FOR SUPERCRITICAL PARAMETERS OF STATE. Kh. I. Amirkhanov and A. M. Kerimov (Dagestan Branch, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 153: 581-4(Nov. 21, 1963). (In Russian)

The constant-volume heat capacity c_v is a convenient and sensitive measure of the liquid-vapor transition of water at temperatures and pressures above the critical point. Previously published data were used to construct curves of $c_v(T)$ for lines of constant pressure; $c_v(v)$ for lines of constant temperature, where v is the specific volume; and lines of constant c_v on the (T,v) and (T,p) planes in the region of $370 \leq T \leq 470°C$, $225 \leq p \leq 400$ atm, and $2 \leq v \leq 10$ cm³/g. The curves $c_v(T)$ pass through a sharp maxima at the critical temperature (374.21°C) for isobars near the critical pressure (225.7 atm), and have properties similar to those for a λ transition. The curves flatten as the pressure increases, decreasing the maximum value of c_v and shifting the maximum to higher temperatures. The isothermal curves of $c_v(v)$ also pass through maxima. On the (T,v) plane, the line $(\partial c_v/\partial v)_T = 0$, which according to thermodynamics should coincide with the critical isochor, $v_{crit} = 3.2$ cm³/g, does so only near the critical temperature; as the temperature increases the line rises to a maximum of 3.52 cm³/g at 415°C, and then parallels the critical isochor. The lines $(\partial c_v/\partial T)_p = 0$ fall below the critical isochor as the temperature increases. From the results it was concluded that the liquid-vapor transition above the critical point takes place within a broad band on the (T,v) plane, since all of the maxima in c_v fall within this band. (TTT)

12056 THE REACTION OF URANIUM TRIOXIDE WITH THE DECOMPOSITION PRODUCTS OF AMMONIA IN THE PRESENCE OF A NUMBER OF EXTRANEOUS OXIDE ADDITIVES. V. M. Zhukovskii and V. G. Vlasov (Urals Polytechnical Inst., USSR). Dokl. Akad. Nauk SSSR, 153: 1077-80(Dec. 11, 1963). (In Russian)

The initial UO_3 had a density of 6.5 g/cm³ and a surface area of 15 m²/g. A total of 5 mole % of ZnO, TiO_2, or $UO_{2.04}$ was used as the oxide additive. The reduction was carried out in a circulating, fluidized-bed reactor at a temperature of 350 to 500°C, and a pressure $P(3H_2 + N_2) = 200$ mg Hg std. The ZnO addition had the greatest effect in accelerating the reduction of UO_3 to UO_2. The addition of TiO_2 had a lesser effect in accelerating the reduction, and the addition of $UO_{2.04}$ slowed down the reduction somewhat. The apparent activation energy increased with increasing conversion of UO_3 to UO_2, because the presence of UO_2 slowed down the reduction process. The following phase conversions can be expected in the reduction of UO_3: $UO_3 \rightarrow U_3O_8 \rightarrow U_3O_{8-x} \rightarrow U_4O_9 \rightarrow UO_{2+x} \rightarrow UO_2$. Mixtures of these phases were detected by x-ray analysis. The oxides ZnO and TiO_2 are n-type semiconductors with an electrical conductivity significantly higher than that of UO_3. Electron transfer takes place from the ZnO or TiO_2 to the UO_3 with an increase in the reduction rate of UO_3. The emf of a UO_3–ZnO couple at 400°C was found to be 240 mv. The oxide $UO_{2.04}$ is a hole conductor which favors the recombination of free electrons, and thus, the reduction of UO_3 to U_3O_8 is slowed down. (TTT)

12057 AN X-RAY STUDY OF THE DOUBLE OXIDES OF A NUMBER OF TRANSITION ELEMENTS. V. K. Trunov, L. M. Kovba, and E. I. Sirotkina (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 153: 1085-8(Dec. 11, 1963). (In Russian)

The formation of double oxides on reacting β-Nb_2O_5 with WO_3, MoO_3, and V_2O_5, and α-Ta_2O_5 with V_2O_5 was investigated by x-ray analysis. The oxide mixture was sintered at 700 to 1200°C in sealed quartz tubes to prevent the volatilization of WO_3 and MoO_3. The following compounds were found in the β-Nb_2O_5–WO_3 system: $WO_3 \cdot 4Nb_2O_5$, $WO_3 \cdot 2Nb_2O_5$, $7WO_3 \cdot 4Nb_2O_5$, $3WO_3 \cdot Nb_2O_5$, and $Nb_2O_5 \cdot nWO_3$ ($n \approx 48$ to 50). In the β-Nb_2O_5–MoO_3 System, the compounds $4Nb_2O_5 \cdot MoO_3$ and $2Nb_2O_5 \cdot MoO_3$ (isostructural with $2Nb_2O_5 \cdot WO_3$) were detected in the oxide mixtures sintered at 1100°C. The oxide mixture containing 75 mole % MoO_3 contained only $Nb_2O_5 \cdot 3MoO_3$. The oxides $7WO_3 \cdot 4Nb_2O_5$, $3MoO_3 \cdot Nb_2O_5$, and $3WO_3 \cdot Nb_2O_5$ are similar to ReO_3 in structure. In the β-Nb_2O_5–V_2O_5 and α-Ta_2O_5–V_2O_5 systems, the existence of the isostructural compounds

$V_2O_5 \cdot 6Me_2O_5$ (14.3% V_2O_5) or $3V_2O_5 \cdot 17Me_2O_5$ (15 mole % V_2O_5) was established, where Me = Nb or Ta. All other oxide mixtures (10, 20, 50, and 90% V_2O_5) were two-phased. (TTT)

12058 THE CHEMISTRY OF THE NOBLE GASES. N. Bartlett. Endeavour, 23: 3-7(Jan. 1964).

The preparation chemistry, and structure of rare gas compounds is reviewed. An assessment of the range of compounds the various rare gases can be expected to form is given. (P.C.H.)

12059 RATES OF SUBSTITUTION REACTIONS OF SQUARE-PLANAR PLATINUM(II) COMPLEXES. I. THE REACTION OF TRANS-DICHLORO-BIS-(TRIETHYLPHOSPHINE)-PLATINUM(II) WITH RADIOCHLORIDE AND NITRIC IONS. Umberto Belluco, Lucio Cattaline, and Aldo Turco (Padua, Italy). J. Am. Chem. Soc., 86: 226-9 (Jan. 20, 1964).

Rates of chloride replacement by nitrite and radiochloride in the platinum(II) complex trans-$[Pt(PEt_3)_2Cl_2]$ are reported. The results show that both first-order and second-order reactions occur. The first-order rate constant for the reaction with NO_2^- is obtained by applying a stationary state treatment. The relative reactivities of Cl^- and NO_2^- are compared with those of similar amino complexes of platinum(II). The bimolecular reactivity of NO_2^- decreases in the reaction with trans-$[Pt(PEt_3)_2Cl_2]$ and this is interpreted in terms of the electrophilic character of the nitrite ion and of the electronic structure of the complex. (auth)

12060 HYPERFINE STRUCTURE IN THE MICROWAVE SPECTRUM OF HDO, HDS, CH_2O, AND CHDO: BEAM-MASER SPECTROSCOPY ON ASYMMETRIC-TOP MOLECULES. P. Thaddeus (Columbia Univ., New York and Goddard Inst. for Space Studies, New York), L. C. Krisher, and J. H. N. Loubser. J. Chem. Phys., 40: 257-73(Jan. 15, 1964).

Hyperfine structure in the $2_{20} \rightarrow 2_{21}$ rotational transition of HDO at 10278.2 Mc/sec and HDS at 11283.8 Mc/sec and in the $2_{11} \rightarrow 2_{12}$ rotational transition of CH_2O at 14488.6 Mc/sec and CHDO at 16038.1 Mc/sec, was investigated with a high-resolution beam maser microwave spectrometer. Linewidths of 5 kc/sec were obtained. The hyperfine Hamiltonian for an arbitrary number of nuclei with quadrupole, spin-rotation, and spin-spin interactions is discussed, and the matrix elements of the Hamiltonian and the intensities of hyperfine transitions calculated in terms of the tabulated 6j coefficients. Quadrupole and spin-rotation constants and bond lengths which were determined are, for the 2_{20} state of HDO: $(eq_JQ)_D = 79.3 \pm 0.3$ kc/sec, $C_H = -43.47 \pm 0.11$ kc/sec, $C_D = -2.33 \pm 0.02$ kc/sec; for the 2_{21} state of HDO: $(eq_JQ)_D = 79.6 \pm 0.3$ kc/sec, $C_H = -43.63 \pm 0.13$ kc/sec, $C_D = -2.20 \pm 0.02$ kc/sec; for the 2_{20} state of HDS: $(eq_JQ)_D = 42.9 \pm 0.4$ kc/sec, $C_H = 25.03 \pm 0.13$ kc/sec $C_D = -0.47 \pm 0.02$ kc/sec; for the 2_{21} state of HDS: $(eq_JQ)_D = 43.3 \pm 0.4$ kc/sec, $C_H = -25.45 \pm 0.13$ kc/sec, $C_D = -0.22 \pm 0.02$ kc/sec; for CH_2O: $C_H(2_{11}) - C_H(2_{12}) = 2.26 \pm 0.13$ kc/sec, $C_H(2_{11}) = 0.65 \pm 0.50$ kc/sec, $\langle 1/r_{HH'}^3 \rangle^{-\frac{1}{3}} = 1.898 \pm 0.017$ Å; for CHDO: $(eV_{ll}Q) = 170.0 \pm 2.0$ kc/sec (where V_{ll} is the second derivative the the electrostatic potential along the CD bond), $C_H(2_{11}) - C_H(2_{12}) = 2.42 \pm 0.50$ kc/sec, $C_D(2_{11}) - C_D(2_{12}) = 0.25 \pm 0.10$ kc/sec, $C_H(2_{11}) = 0.2 \pm 1.0$ kc/sec, $C_D(2_{11}) = 0.13 \pm 0.20$ kc/sec, and $\langle 1/r_{HD}^3 \rangle^{-\frac{1}{3}} = 1.88 \pm 0.10$ Å. The V_{ll} calculated from the deuteron quadrupole coupling constants are, for HDO: 1.56×10^{15} statvolt/cm^2; for HDS: 0.76×10^{15} statvolt/cm^2; and for CHDO: 0.83×10^{15} statvolt/cm^2. (auth)

12061 VAPORIZATION PROCESSES INVOLVING SULFUR. J. Berkowitz and W. A. Chupka (Argonne National Lab., Ill.). J. Chem. Phys., 40: 287-95(Jan. 15, 1964).

Free evaporation of rhombic sulfur is shown to give rise solely to S_8 vapor molecules, whereas the sublimation of an allotropic form (Engel's sulfur) produces only S_8 vapor molecules. The vapor composition characteristic of equilibrium can be produced by mixing any allotropic form of sulfur with commercial Al_2O_3, which evidently catalyzes the transformation among sulfur species. The evaporation coefficients of S_8 and S_7 molecules from a rhombic sulfur surface were measured. The behavior of other allotropes (S_μ,S_π) is described as observed by mass spectrometry. Mass spectra of S_8 and S_8 molecules were determined directly as a function of temperature and that of S_7 deduced from a vapor mixture of S_8, S_7, and S_8. Ionization efficiency curves and appearance potentials of the major ionic species are reported. Paramagnetic resonance measurements were used to help elucidate the mechanism of catalysis. (auth)

12062 MAGNETIC SUSCEPTIBILITIES OF SEVERAL PARAMAGNETIC SALTS AT LIQUID He^3 TEMPERATURES. J. T. Schriempf and S. A. Friedberg (Carnegie Inst. of Tech., Pittsburgh). J. Chem. Phys., 40: 296-302(Jan. 15, 1964).

A cryostat is described in which magnetic susceptibility measurements may be made by an audio-frequency mutual induction technique at temperatures down to 0.35°K. Below 2°K the specimens are in direct contact with liquid He^3. Results of measurements on several compounds are presented. The powder susceptibility of $[Cr_3(CH_3COO)_6(OH)_2]Cl \cdot 8H_2O$ was found to obey a Curie-Weiss law. Both powdered $Co(CH_3COO)_2 \cdot 4H_2O$ and powdered $Ni(CH_3COO)_2 \cdot 4H_2O$ are observed to be paramagnetic to the lowest temperatures attained; the former salt does not exhibit the anomaly at 0.6°K found in earlier studies employing a magnetic cooling technique. The powder susceptibility of $Mn(HCOO)_2 \cdot 2H_2O$ suggests the existence of significant coupling among many of the Mn^{2+} moments, but no evidence was found of a cooperative transition above 0.56°K. (auth)

12063 INFRARED AND RAMAN SPECTRA OF DIGERMANE. James E. Griffiths and George E. Walrafen (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys. 40: 321-8(Jan. 15, 1964).

Infrared spectra of gaseous digermane and of digermane-d_6 were recorded under medium resolution from 4000-250 cm^{-1} and the Raman displacements were obtained photoelectrically from 100-2600 cm^{-1} for the liquid state. The 12 fundamental frequencies for each molecule were assigned to the normal modes and digermane was found to have the D_{3d} ethanelike structure. The rotational structures of the e_u fundamentals of Ge_2H_6 and the ν_3 fundamental of Ge_2D_6 were resolved and analyzed. Results from the zeta sum rule confirmed the hindered rotator structure and four combination bands were used to estimate the barrier hindering internal rotation as 1490 ± 200 cal/mole. (auth)

12064 REFINEMENT OF PETERSON AND LEVY'S NEUTRON DIFFRACTION DATA ON KHF_2. James A. Ibers (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 40: 402-4(Jan. 15, 1964). (BNL-7227)

The neutron-diffraction data obtained by Peterson and Levy from a single crystal of KHF_2 were refined in an attempt to settle the question of the geometry of the bifluoride ion in KHF_2. It turns out to be impossible from the neutron diffraction data alone to distinguish a linear symmetric F-H-F ion from a linear one in which the hydrogen occupies two equally probable positions on either side

of the center, even when these positions are 0.16 Å from the center. However, the agreement between the differences in mean-square amplitudes of vibration of hydrogen and fluorine along the bond as obtained from an analysis of the diffraction data and as calculated from spectroscopic data lends support to a linear symmetric model of the bifluoride ion in KHF_2. The F–H–F distance is 2.277 ± 0.006 Å. (auth)

12065 NEUTRON DIFFRACTION REFINEMENT OF $CaWO_4$. M. I. Kay (Georgia Inst. of Tech., Atlanta), B. C. Frazer, and I. Almodovar. J. Chem. Phys., 40: 504-15 (Jan. 15, 1964). (BNL-7314)

The $CaWO_4$ structure was refined, starting with the parameters of Sillén and Nylander, using two zones of neutron diffraction data. The oxygen coordinates with the origin of the cell at the W atom ($\bar{4}$) are x = 0.2413 (σ = 0.0005), y = 0.1511 (σ = 0.0006), z = 0.0861 (σ = 0.0001). The slightly distorted WO_4 tetrahedron contains a W–O distance of 1.788 Å (σ = 0.003) and angles of 113°27′ (σ = 14′) and 107°56′ (σ = 0.09′). Close nonbonded approaches are Ca–O = 2.48 and O–O = 2.77 Å. Anisotropic thermal vibration parameters were also determined. (auth)

12066 TRIPLE IONIZATION IN SMALL MOLECULES. Amos S. Newton (Univ. of California, Berkeley). J. Chem. Phys., 40: 607-8(Jan. 15, 1964). (UCRL-10936)

The appearance potential of the M/q = 25⅓ and M/q = 38 (CS_2^{3+}) peaks in the mass spectrum of CS_2 were determined using He^+, Kr^{2+}, and Kr^{3+} as internal standards. The values found were 27.4 ± 0.2 ev for CS_2^{3+} and 53.6 ± 0.5 ev for CS_2^{3+}. Comparing members of the series CO_2, COS, and CS_2, no detectable triply charged ion of CO_2 was found. In COS however, there exists a definite but small triply charged ion. Another small molecule in which a triply charged parent ion was observed is cyanogen. The ion $C_2N_2^{3+}$ at M/q = 17⅓ at 70 v nominal ionizing voltage has a pattern factor of 0.0005% compared to the parent and base peak at M/q = 52. At 120 v nominal ionizing voltage the pattern factor of M/q = 17⅓ is 0.002%. It was concluded that stable states of triply charged ions of even small molecules exist provided there is a sufficient number of nonbonding or delocalized electrons in the molecule. (P.C.H.)

12067 HYDROGEN ISOTOPE EFFECTS IN SONOCHEMICAL REACTIONS IN WATER. M. Anbar and I. Pecht (Weizmann Inst. of Science, Rehovoth, Israel). J. Chem. Phys., 40: 608-9(Jan. 15, 1964).

Water and dilute (0.1 M) sodium formate solutions of different isotopic composition were subjected to sonolysis under argon in a specially constructed irradiation vessel, using a 0.8 Mc/sec ultrasonic generator. Water containing 50.0 at. % D (pH = 5.5), was subjected to sonolysis and yielded hydrogen with an isotopic composition of 47.0 ± 1% D. No isotope effect within the experimental error could be detected in the molecular hydrogen. DCO_2Na (0.1 M), 98% D was sonolyzed in H_2O. The hydrogen evolved contained HD/H_2 = 0.036 ± 0.002. Formate 0.1 M 50 at. % D yielded under the same conditions HD/H_2 0.0103 ± 0.0005. From these values, the isotope effect of hydrogen abstraction was calculated. (P.C.H.)

12068 FAR-UV SPECTRA OF NO_3^- AND I^- IN MOLTEN SALT MEDIA. David W. James, Charles R. Boston, and G. Pedro Smith (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 40: 609-10(Jan. 15, 1964).

The uv spectrum of the nitrate ion was measured for dilute solutions of $LiNO_3$ in molten $LiClO_4$ at 140°C. The spectra had a weak band at 4.39 ev (283 mμ) with ϵ = 17.4 l/mole · cm and $f = 4.0 \times 10^{-4}$, and an intense band at 6.37 ev (195 mμ) with ϵ = 8270 and f = 0.33. The uv spectrum of the iodide ion was measured for dilute solutions of KI in a LiCl–KCl eutectic melt at 363°C. The first charge-transfer band was found at 5.97 ev (208 mμ) with ϵ = 9670 and f = 0.29. (P.C.H.)

12069 SOLVATION APPROACH TO ION SOLVENT INTERACTION. J. Padova (Soreq Research Establishment, Nahal Soreq, Israel). J. Chem. Phys., 40: 691-4 (Feb. 1, 1964).

From the hard-sphere model proposed, i.e., that the ion and its solvation layer are incompressible, and from density and compressibility data, the variation of solvation number with concentration, the intrinsic volume of ions, and the mean distance of approach are obtained. These properties of the ions, and the molar refractions, the dipole moment of the ion pair, and the viscosity, are correlated via the solvated molar volume ϕ_s. (auth)

12070 METASTABLE STATE OF THE DOUBLY CHARGED CARBON DIOXIDE ION. Amos S. Newton and A. F. Sciamanna (Univ. of California, Berkeley). J. Chem. Phys., 40: 718-23(Feb. 1, 1964). (UCRL-10922)

A metastable state in CO_2^{2+} dissociating into $CO^+ + O^+$ with a half life of 2.3 ± 0.2 μsec was observed. The corresponding metastable peaks are observed at $(M_1/q_1)^*$ = 35.6 and $(M_2/q_2)^*$ = 11.6, respectively. The widening of these peaks with accelerating voltage shows the repulsion energy to be 2.7 ev and the corresponding charge separation at fragmentation to be 5.3 Å. The appearance potential of CO_2^{2+} was found to be 38.0 ± 0.2 ev, and this value is discussed in terms of the various repulsion energies and energy balances. The data is consistent with the hypothesis of an immediate fragmentation into $CO^+(^2\Sigma)$ and O^+ and the metastable fragmentation into $CO^+(^2\Pi_i)$ and O^+. The fragmentation of CO_2^{2+} enriched in O^{18} was also reinvestigated. It is shown that the unsymmetrical doubly charged molecule ion ($CO^{16}O^{18++}$) has a lower yield than the corresponding symmetrical molecule ions containing O^{16} and O^{18}, respectively. (auth)

12071 NUCLEAR MAGNETIC RESONANCE AND MOLECULAR FIELD APPROXIMATION IN $KCoF_3$. Tung Tsang (Argonne National Lab., Ill.). J. Chem. Phys., 40: 729-33(Feb. 1, 1964).

A molecular field calculation and a nuclear magnetic resonance study of F^{19} in paramagnetic $KCoF_3$ are reported. The isotropic hyperfine interaction indicates presence of 0.57% unpaired 2s spins in F^- orbitals from each Co^{2+} neighbor. The calculations are shown to be in good agreement with the F^{19} resonance data and also the susceptibility data of others. (auth)

12072 SYMMETRY COORDINATES AND LATTICE VIBRATIONS OF $LaCl_3$. J. Murphy, H. H. Caspers, and R. A. Buchanan (Naval Ordnance Lab., Corona, Calif.). J. Chem. Phys., 40: 743-53(Feb. 1, 1964).

Symmetry coordinates for the 24k = 0 modes of $LaCl_3$ are derived. The symmetry coordinates form a basis in terms of which the normal modes are expanded. From a group theoretical analysis of the $C_{3h}^3(p6_3/m)$ space group, it was determined that there are three infrared-active ($1A_{1u}$ and $2E_{1u}$), six Raman-active ($2A_{1g}$, $1E_{1g}$, and $3E_{2g}$), and five nonactive ($2B_g$, $2B_u$, and $1E_{2u}$) vibrational modes. Three infrared absorption bands were observed in evaporated $LaCl_3$ films at 138, 165, and 210 cm^{-1}. Three force parameters were determined using the wavenumbers of the infrared-active modes. The wavenumbers of the other modes were expressed as functions of the fourth force

parameter. For one value of this parameter, agreement with the observed Raman lines was obtained with an average deviation of 6.6 cm^{-1}. (auth)

12073 VIBRATIONAL ANALYSIS OF SUBSTITUTED AND PERTURBED MOLECULES. I. THE EXACT ISOTOPE RULE FOR MOLECULES. R. E. DeWames and T. Wolfram (North American Aviation Science Center, Canoga Park, Calif.). J. Chem. Phys., 40: 853-9(Feb. 1, 1964).

Green's function and partitioning techniques developed for treating the lattice-impurity problem were applied to molecular systems. The vibrational frequencies of isotopically substituted molecules are obtained exactly and explicitly without recourse to a force constant model. It is shown that the mixing of the symmetry coordinates of the unperturbed molecule is determined uniquely from the experimental frequencies. The usual product rule is obtained; however, it does not involve the moments of inertia. The more general problem involving changes in the bond strength is formally presented. Explicit expressions for the vibrational frequencies for any isotopic substitution of a nonlinear XY_2 molecule are derived. Numerical results for H_2O and H_2S are given. (auth)

12074 APPLICATION OF THE PLATT ELECTROSTATIC MODEL TO DIATOMIC HYDRIDE IONS. T. F. Moran and L. Friedman (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 40: 860-6(Feb. 1, 1964). (BNL-7428)

The Platt electrostatic model for calculating equilibrium internuclear distances and force constants of diatomic hydride molecules was used to calculate properties of diatomic hydride ions. An empirical approach to the scaling technique was employed in order to render the model consistent with the quantum mechanical virial theorem. This has the additional advantage of improving the calculated equilibrium properties. For twelve known hydride ions there is satisfactory agreement between calculated and experimentally measured force constants and equilibrium internuclear distances. The applicability of the relation Kr_e/D_0 = const. to a sequence of similar diatomic ions was briefly examined. Calculated values of K and r_e were used in the above relation to estimate dissociation energies of the rare-gas hydride ions. Results are compared with experimental limits determined from mass spectrographic investigations. Equilibrium properties of the corresponding neutral species calculated by the Platt electrostatic model are consistent with the generally assumed instability of the rare gas hydride molecules. (auth)

12075 THERMODYNAMIC PROPERTIES OF GASEOUS YTTRIUM MONOXIDE. CORRELATION OF BONDING IN GROUP III TRANSITION-METAL MONOXIDES. R. J. Ackermann, E. G. Rauh, and R. J. Thorn (Argonne National Lab., Ill.). J. Chem. Phys., 40: 883-9(Feb. 1, 1964).

The vapor from solid yttrium sesquioxide contained in a Knudsen cell made of tungsten was investigated by measuring the absolute effusion rate and by studying the effusate in a mass spectrometer. The latter demonstrates that the gaseous species are yttrium monoxide, oxygen, and a small amount of yttrium. From measurements of the appearance potentials for the ions it was concluded that the ratio of monoxide-to-metal is at least 65 and that above 15 ev significant fragmentation of YO by the ionizing electrons to yield Y^+ occurs. From the absolute effusion rates one derives the free energy of formation, $\Delta F_f^0(YO,g) = -21{,}800 - 10.96\ T$, and the dissociation energy, 7.31 ± 0.10 ev, for gaseous yttrium monoxide. A correlation of the dissociation energies and the molecular parameters of the monoxides of Group III transition metals indicates that the unexpected increase in bonding with increasing radii is accompanied by an increase in the electronic entropy of the metal atom. The correlation demonstrates the role of excited atomic states in chemical bonding. (auth)

12076 LYMAN ALPHA LAMPS AND REACTION OF DEUTERIUM ATOMS IN THE ^2P STATE WITH MOLECULAR NITROGEN. Inosuke Koyano and Ikuzo Tanaka (Tokyo Inst. of Tech.). J. Chem. Phys., 40: 895-8(Feb. 1, 1964).

Characteristics of hydrogen- and deuterium-Lyman alpha, emitted from their respective electrodic discharge lamps, were investigated, and the optimum conditions were determined for the production of resonance lines of sufficient intensity and sharpness for producing $H(^2P)$ or $D(^2P)$ atoms by irradiation of the ground-state atoms. Reactions between $H(^2P)$ or $D(^2P)$ atoms and molecular nitrogen were also studied by irradiating the mixtures H + N_2 or D + N_2 with H Lyman alpha or D Lyman alpha. The relation between the amount of the product and the rate of ^2P atom formation was examined, and it was found that the former is strongly affected by the latter. (P.C.H.)

12077 COORDINATION OF FLUORIDE IONS ABOUT NICKEL (II) IONS IN THE MOLTEN LiF–NaF–KF EUTECTIC. J. P. Young and G. Pedro Smith (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 40: 913-14(Feb. 1, 1964).

The absorption spectrum of NiF_2 dissolved in the molten eutectic salt, 46.5 mole % LiF–11.5 mole % NaF–42.0 mole % KF, was measured between 5000 and 30000 cm^{-1} at high temperatures. The results show that Ni(II) ions exist in octahedral (or quasioctahedral) fields of fluoride ions. (P.C.H.)

12078 SOME DIELECTRIC PROPERTIES OF TANTALUM PENTOXIDE. A. S. Pavlovic (West Virginia Univ., Morgantown). J. Chem. Phys., 40: 951-6(Feb. 15, 1964).

The dielectric constant and dissipation factor of β- and α-Ta_2O_5 ceramics and of plates cut from a boule of α-Ta_2O_5 were measured from 77 to 373°K over a frequency range from 100 cps to 100 kc/sec. β-Ta_2O_5 ceramics behave as typical dielectric materials. On the other hand, α-Ta_2O_5 ceramics exhibit large migrational losses, similar to those found in glasses, due to the migration of the tantalum ion through the structure. The activation energy Q of the process is estimated to be about 0.64 ev, in close agreement with 0.71 ev found from the formation of anodic films on tantalum. This and other facts suggest that anodic tantalum pentoxide is similar to that of the α form. A large relaxation peak is found in the data for boule α-Ta_2O_5 material having Q = 0.2 ev and $\tau_0 = 10^{-16}$ sec. This peak must arise from a large deformation of the structure to account for such a large relaxation time and large dielectric constant peak. (auth)

12079 INFRARED SPECTRUM OF CARBON DIOXIDE ENRICHED IN OXYGEN-18. Charles V. Berney and David F. Eggers, Jr. (Univ. of Washington, Seattle). J. Chem. Phys., 40: 990-1000(Feb. 15, 1964).

The infrared spectrum of a sample of carbon dioxide enriched to about 10 at. % with O^{18} was examined in the region 1620–5400 cm^{-1}, using an Ebert grating spectrometer with spectral slitwidths ranging from 0.2 to 0.4 cm^{-1}. Ten previously unreported bands were analyzed and assigned to various species of O^{18} substituted carbon dioxide

and Courtoy's results for $C^{12}O^{16}O^{18}$ in the 2-μ region were confirmed. Courtoy's unexpectedly high value for the Fermi resonance constant of this species was confirmed by the separation of previously unreported Fermi-resonant bands. The positions of the two bands assigned to $C^{12}O_2^{18}$ suggest that the resonance constant for this species is larger still. A resonance interaction was found in $C^{12}O^{16}O^{18}$, dependent on the potential constant k_{113}. (auth)

12080 CLASSICAL MODEL FOR THE STUDY OF ISOTOPE EFFECTS IN ENERGY EXCHANGE AND PARTICLE EXCHANGE REACTIONS. Robert J. Rubin (National Bureau of Standards, Washington, D. C.). J. Chem. Phys., 40: 1069-77(Feb. 15, 1964).

An idealized model of a collinear collision between a diatomic molecule AB and an atom C was studied. The three-atom potential-energy surface is an L-shaped region consisting of two flat-bottomed troughs with vertical walls; and the rectangular corner region of the L is at a higher uniform potential. The dependence of the classical energy exchange probability on the relative masses of the three particles is investigated systematically for this model. All possible collisions are considered in which the initial distribution of energy between the vibrational and relative translational components is fixed. Formulas are derived that express the average fraction of vibrational energy after collision as a function of the fraction of vibrational energy before collision. In the reaction AB + C → A + BC, the dependence of the classical particle-exchange probability on the relative mass of Particles A and C is determined in the limiting case where the mass of Particle B is infinite. In addition to the relative mass parameter, the particle exchange probability depends upon the initial vibrational and relative translational energies and the height of the potential barrier in the corner region V_{II}. A thermal average probability for particle exchange is determined that depends upon two parameters: the relative mass of A and C and V_{II}/kT. This dependence on the relative mass, an isotope effect, is a product of classical mechanics. (auth)

12081 CHEMICAL SHIFTS OF Pb^{207} IN PEROVSKITE FERROELECTRICS. David H. Anderson (Sandia Lab., Albuquerque, N. Mex.). J. Chem. Phys., 40: 1168-9 (Feb. 15, 1964). (TID-19269; SCDC-3398)

Lead-207 chemical shift measurements were used as a means of determining covalent bond character in ferroelectrics, in attempts to gain insight into the ferroelectric mechanism. Shifts, defined as $H-H_0/H \times 100$ (H_0 = field for Pb resonance), were observed in ferroelectrics: Pb $(Zr_{0.68}Ti_{0.07}Sn_{0.25})$ O_3, 1.22; $PbTiO_3$, 1.23; antiferroelectrics: $PbZrO_3$, 1.23; $PbHfO_3$ (+1 at. % Nb_2O_5), 1.24. Lead (meta) niobate ($PbNb_2O_6$), and lead (meta) tantalate ($PbTa_2O_6$), though not perovskites, were examined, but no signals were observed. It is noted that the shifts observed in the perovskite ferroelectrics and antiferroelectrics were all in the covalent range, about 1.2 compared with ionic compounds. Also, the fact that no significant changes in chemical shift were observed over a temperature range that included the transition region indicates that changes in the lead-ion covalent character do not cause the ferroelectric (or antiferroelectric) transition. (P.C.H.)

12082 THE PRODUCTION OF COMPLEXES OF RARE EARTHS WITH α-HYDROXYCARBOXYLIC ACID. K. E. Seyb (Johannes Gutenberg Universität, Mainz). J. Inorg. Nucl. Chem., 26: 231-7(Feb. 1964). (In German)

The distribution of trace amounts of rare earths between ion exchange resins and ammonium salt solutions of α-hydroxy-isocarboxylic acids need not be explained by assuming complexes containing more than three ligands, if a dissociation of the hydroxy group is taken into account. (auth)

12083 ELECTRODEPOSITION OF PROTACTINIUM. H. Shimojima and J. Takagi (NAIG Nuclear Research Lab., Kawasaki, Japan). J. Inorg. Nucl. Chem., 26: 253-5(Feb. 1964).

The electrodeposition of protactinium was investigated by using mainly ammonium formate-sulfuric acid aqueous solution. Eighty per cent of protactinium was electrodeposited from 0.1 N ammonium formate–0.1 N sulfuric acid solution under a constant current density of 80 ma/cm^2 at room temperature. From the result of α spectrometry the deposited film of protactinium is considered to be thin and uniform enough to be used for α counting and α spectrometry. (auth)

12084 AQUEOUS SYSTEMS AT HIGH TEMPERATURE. XII. THE COMPOUND $NiO \cdot 3UO_3$. William L. Marshall and James S. Gill (Oak Ridge National Lab., Tennessee). J. Inorg. Nucl. Chem., 26: 277-80(Feb. 1964).

A double oxide of UO_3 and NiO was synthesized at 300°C in the systems $UO_3-NiO-SO_3-H_2O$ and $UO_3-NiO-N_2O_5-H_2O$. The most probable composition for this new compound is shown to be $NiO \cdot 3UO_3$. It was observed to be thermally stable to somewhat above 900°C. The method of preparation, analysis, and some characterization of the compound are given. (auth)

12085 AQUEOUS SYSTEMS AT HIGH TEMPERATURE. XIII. INVESTIGATIONS ON THE SYSTEM $UO_3-Li_2O-SO_3-D_2O$; LIQUID-LIQUID IMMISCIBILITY AND CRITICAL PHENOMENA, 300-410°C. Ernest V. Jones and William L. Marshall (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem., 26: 281-5(Feb. 1964).

Temperatures for the appearances of critical phenomena (where liquid ≡ vapor) and liquid–liquid immiscibility were determined in the condensed system $UO_3-Li_2O-SO_3-D_2O$ at concentrations of SO_3 from 0.05 to 1.0 molal, molal ratios, R = Σ(metallic oxides): SO_3, from 0 to 1.0 and at molal ratios, R(MO) = UO_3 : Li_2O, of 3 : 1, 1 : 1, and 1 : 3. Critical phenomena were observed at temperatures from 374 to 410°C for solutions of R varying from 0 to between 0.2 and 0.5 depending upon R(MO) and the molality of SO_3. At higher values of R, boundaries of liquid–liquid immiscibility were observed at temperatures between 300 and 400°C. As R approached unity and m_{SO_3} decreased, precipitation of a solid phase occurred before the temperatures of liquid–liquid immiscibility were reached. Based on these data and information obtained previously on the systems $UO_3-SO_3-D_2O$ and $Li_2SO_4-D_2SO_4-D_2O$, isotherms were drawn to describe boundary limits of liquid–liquid immiscibility, critical phenomena, and appearance of solids in the system $UO_3-Li_2O-SO_3-D_2O$. (auth)

12086 THERMAL INSTABILITY OF CERIUM(IV) SULPHURIC ACID SOLUTIONS. D. Grant (Glasgow Univ.). J. Inorg. Nucl. Chem., 26: 337-46(Feb. 1964).

Autoreduction of cerium(IV) sulfate in aqueous sulfuric acid occurs above 40°C in the presence of a glass surface that acts as a catalyst. The reaction, which is approximately zero order, stops when the products of the reaction deactivate the catalyst surface. Cerium(IV) containing solids and added Ag(I) and Hg(II) ions also catalyse the reaction. No demonstrable dependence on the bulk cerium(IV) or cerium(III) concentrations could be found. Although no clear cut dependence on temperature was ob-

served from 40 to 100°C the reaction proceeds notably faster at reflux temperature. (auth)

12087 CHRONOPOTENTIOMETRIC DETERMINATION OF INTERDIFFUSION COEFFICIENTS AND HEATS OF INTERDIFFUSION IN MOLTEN SALTS. C. E. Thalmayer, S. Bruckenstein, and D. M. Gruen (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 26: 347-57(Feb. 1964).

Chronopotentiometry was used to determine the interdiffusion coefficients and heats of activation for Ag^+, Cd^{2+}, Pb^{2+}, Bi^{3+}, and U^{4+} in lithium chloride–potassium chloride eutectic and for Ag^+ in molten sodium nitrate and in molten cesium nitrate. In LiCl–KCl, the diffusion coefficients in $cm^2/sec \times 10^6$ at 400°C, and the heats of activation for diffusion in kcal/mole are given after the ionic species with errors indicated: Ag^+: 24. ± 7., 5.8 ± 0.2; Cd^{2+}: 12.1 ± 2., 6.5 ± 0.3; Pb^{2+}: 8.9 ± 2., 7.9 ± 0.1; Bi^{3+}: 6.3 ± 1., 9.8 ± 1., U^{4+}: 4.9, 7.7. The temperature range studied was approximately 365–750°C. The diffusion coefficient and heat of activation for diffusion for Ag^+ in sodium nitrate (in the same form as above) is 32.5 ± 0.2, 4.52 ± 0.1, and in cesium nitrate is 24.8 ± 2. and 5.06 ± 0.1. The data indicate interdiffusion proceeds by a mechanism other than viscous flow, and are consistent with transport by ion-diameter jumps into ion-sized holes. Significant transport via a paired vacancy mechanism is not supported for interdiffusion in these melts. (auth)

12088 RARE EARTH DIBENZOYLMETHIDES PREPARATION, DEHYDRATION AND THERMAL STABILITY. R. G. Charles and A. Perrotto (Westinghouse Research Corp., Pittsburgh). J. Inorg. Nucl. Chem., 26: 373-6 (Feb. 1964).

A thermogravimetric study was made on the rare earth dibenzoylmethides in an inert atmosphere at atmospheric pressure. A general synthetic procedure by which most of the lanthanide dibenzoylmethide hydrates can be prepared in adequate yield and purity is described. The slow addition of aqueous ammonia to an ethanol-water mixture containing rare earth chloride, which is kept saturated with excess solid dibenzoylmethane, precipitates the compounds as hydrates. Thermogravimetric curves for hydrated rare earth dibenzoylmethides heated in an argon atmosphere are presented. (P.C.H.)

12089 COMPLEXES OF URANIUM(VI), URANIUM(IV) AND VANADIUM(IV) WITH TRIPHENYLPHOSPHINE. A. K. Majumdar, A. K. Mukherjee, and R. G. Bhattacharya (Jadavpur Univ., Calcutta). J. Inorg. Nucl. Chem., 26: 386-7(Feb. 1964).

The isolation of stable complexes of U(VI), U(IV), and V(IV) with triphenylphosphine as a monoligand is reported. The diamagnetic U(VI) complexes are of the type $UO_2X_2 \cdot 2(C_6H_5)_3P$, where X = Cl, Br, I, and NO_3. Properties of the complexes are given. (P.C.H.)

12090 THE EFFECT OF PRESSURE ON THE DISSOCIATION OF LANTHANUM FERRICYANIDE ION PAIRS IN WATER. S. D. Hamann, P. J. Pearce, and W. Strauss (Commonwealth Scientific and Industrial Research Organization, Melbourne and Univ. of Melbourne). J. Phys. Chem., 68: 375-80(Feb. 1964).

Conductometric measurements of the influence of pressure on the molal dissociation constant K_m of lanthanum ferricyanide ion pairs in water at 25°C are described. The value of K_m increases by a factor of 1.7 between 1 and 2000 atm, and the initial trend corresponds to a change in partial molar volume of −8.0 cm^3/mole for dissociation at 1 atm. The results agree quite well with the predictions of the ion-association theories of Bjerrum and of Fuoss, if it is assumed that the contact distance, a, is independent of pressure and that the change of K_m arises only from the increases in dielectric constant and density that occur when water is compressed. (auth)

12091 IONIZATION OF SOME WEAK ACIDS IN WATER–HEAVY WATER MIXTURES. Pentti Salomaa, Larry L. Schaleger, and F. A. Long (Cornell Univ., Ithaca, N. Y.). J. Phys. Chem., 68: 410-11(Feb. 1964).

Measurements of the dissociation constants of ammonium, hydrazoic acid, and chloroacetic acid were made in mixtures of light and heavy water by the glass electrode method. The results obtained are in good agreement with previously recorded values. (P.C.H.)

12092 REDUCTION OF PLATINUM OXIDE BY ORGANIC COMPOUNDS. CATALYTIC SELF-ACTIVATION IN DEUTERIUM EXCHANGE REACTIONS. J. L. Garnett and W. A. Sollich (Univ. of New South Wales, Kensington). J. Phys. Chem., 68: 436-7(Feb. 1964).

The reduction of platinum oxide ($PtO_2 \cdot 2H_2O$) by organic compounds and the subsequent use of this self-activated catalyst in exchange reactions is reported. Benzene, biphenyl, dibenzyl, cyclohexene, n-octane, cyclohexane, and naphthalene self-activated unreduced platinum oxide with or without the presence of water at 120°C. The first four compounds also exchange readily under these conditions while n-octane and cyclohexane react slowly, although more efficiently than in the presence of a prereduced platinum catalyst. Naphthalene self-activates platinum oxide but does not appreciably exchange with D_2O. It was concluded that the self-activation process offers a convenient tritiation procedure for a large range of compounds without the necessity for hydrogen preactivation of the catalyst. (P.C.H.)

12093 PLUTONYL SPECIES IN MOLTEN CHLORIDE SALT SOLUTIONS. J. L. Swanson (General Electric Co., Hanford Atomic Products Operation, Richland, Wash.). J. Phys. Chem., 68: 438-9(Feb. 1964). (HW-SA-3223)

Molten chloride salt solutions containing plutonyl (V) and plutonyl (VI) were prepared by reacting dissolved Pu(III) and (IV) with an O_2-Cl_2 gas stream. The spectra of two LiCl–CsCl eutectic solutions containing plutonyl(V) and (VI) are illustrated. The behavior of the plutonyl species under various conditions was studied spectrophotometrically. The ratio of plutonyl(V) to plutonyl(VI) in O_2-Cl_2 sparged solutions was found to vary inversely with the square root of the concentration of Cl_2 in the sparge gas. (P.C.H.)

12094 CHEMICAL SHIFT, RELAXATION TIME, AND ELECTRIC QUADRUPOLE COUPLING IN ALKALI HALIDES. Yukio Yamagata (Kanazawa Univ., Japan). J. Phys. Soc. Japan, 19: 10-23(Jan. 1964).

Chemical shift and spin lattice relaxation times are measured for Cl^{35} in all the alkali chloride crystals and for Br^{79} and I^{127} in some of the halides. These measured values cannot be explained by using only Kondo-Yamashita's theory, which takes into account the effect of overlap between the central ion and the nearest neighbors. For the chemical shift, it seems that the overlap with the second nearest neighbors is an essential cause of the discrepancy and that the covalent and the electrostatic effects are rather small. If these conclusions are admitted, there must be a large chemical shift (about $-2 \sim -3 \times 10^{-4}$) of chlorine ion in aqueous solution relative to the free chlorine ion. A model combining the electrostatic and the overlap effect is proposed to explain reasonably the relaxation times in the crystals. The electric quadrupole

coupling in free molecules of alkali halides is also discussed from the present viewpoint. The combination of the electrostatic and the overlap effects seems to give a reasonable explanation for the observed values. (auth)

12095 ON PRECIPITATION EFFECTS OF ALUMINUM, LANTHANUM, IRON(III), AND THORIUM PHOSPHATES. E. Matijevic and I. Milic (Univ. of Zagreb). Kolloid-Z., 188: 129-36(Apr. 1963).

Typical precipitation curves of metal phosphates were obtained using the turbidimetric technique for: $Al(NO_3)_3-K_3PO_4$, $Al(NO_3)_3-KH_2PO_4$, $Al(NO_3)_3-NaH_2PO_4$, $FeCl_3-K_3PO_4$, $FeCl_3-(NH_4)_2HPO_4$, $FeCl_3-K_2HPO_4$, $FeCl_3-KH_2PO_4$, $FeCl_3-NaH_2PO_4$, $La(NO_3)_3-K_3PO_4$, $La(NO_3)_3-K_2HPO_4$, $La(NO_3)_3-KH_2PO_4$, $La(NO_3)_3-NaH_2PO_4$, and $Th(NO_3)_4-K_2HPO_4$. The curves indicate concentration ranges of phosphate precipitation and of complex solubility. Precipitation curves of La phosphates show distinct differences from analogous curves for Al and Fe(III) phosphates. In curves obtained when $La(NO_3)_3$ and K_3PO_4 served as precipitating components, there is a minimum in the equivalent range and 2 maxima develop, one on each end of the curve, that is at the high excess of either of the precipitants. The minimum is caused by the formation of relatively stable colloidal precipitates, and the 2 maxima are apparently the concentration maxima. The drop in turbidity at high excess concentration of either precipitating component may indicate a tendency for formation of soluble La complex species. Similar results were obtained using primary and secondary phosphates and La nitrate. The tendency of La to form complexes with phosphates is considerably smaller than in the case of Al and Fe(III) ions. Thorium phosphates form jellylike colloidal precipitates when prepared in higher concentrations, so attempts were made to obtain the typical precipitation curves for Th phosphates in low concentrations. Several such curves using K_2HPO_4 as the phosphate component are shown. (TCO)

12096 PREPARATION OF ION-MOLECULES OF THE INERT GASES IN AN ELECTROMAGNETIC ISOTOPE SEPARATOR. J. H. Freeman and R. W. McIlroy (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nature, 201: 69-70(Jan. 4, 1964).

Well-defined beams of the ion molecules $LiAr^+$, $LiKr^+$, and $RbAr^+$ were identified in an electromagnetic isotope separator. The ion beams were produced by running the discharge of the ion source on a mixture of the inert gas and the vapor of the alkali iodide. At a total extracted ion beam intensity of several milliamperes (mainly Li^+ and I^+), microampere beams of the compound ions were produced. (M.C.G.)

12097 ABSORPTION SPECTRA OF TRANSIENT CHEMICAL SPECIES PRODUCED IN GASES BY A SINGLE-PULSE MICROWAVE-DISCHARGE. A. B. Callear, J. A. Green, and G. J. Williams (Cambridge Univ., Eng.). Nature, 201: 70-2(Jan. 4, 1964).

In order to produce a high concentration of transient chemical species in a gas, an apparatus was constructed that produces a short-duration electric discharge by means of a single microwave pulse, with a peak power of 8×10^4 w. It was demonstrated that the absorption spectra of metastable atoms and free radicals present in the gas discharges can be photographed by absorption spectroscopy. Preliminary studies were made of helium, nitrogen–mercury mixtures, carbon disulfide, and cyanogen. (M.C.G.)

12098 A LITHIUM–SCANDIUM–MOLYBDENUM(IV) OXIDE. Paul C. Donohue and Lewis Katz (Univ. of Connecticut, Storrs). Nature, 201: 180-1(Jan. 11, 1964).

A product was obtained with the reagents Li_2O, Sc_2O_3, and MoO_2 in the mole ratios of 1:1:6. A postulated structure for the compound is presented that corresponds to $LiScMo_3O_8$. (C.H.)

12099 EXCHANGE ADSORPTION OF STRONTIUM ION BY CALCINED MONTMORILLONITE. Mutsumi Nishidoi and Zenzo Yokozeki (Kurita Ind. Co., Ltd., Japan). Nippon Genshiryoku Gakkaishi, 5: 985-9(Dec. 1963). (In Japanese)

A new swellingless and large particle exchanger was prepared by calcination of bentonite and its adsorbability for strontium ion was examined. The calcination is not affective to the exchange capacity up to 500°C; it decreases with the rise of calcination temperature above 500°C. The rate of the decrease in its capacity was maximum in the exchanger treated with sodium hydroxide. Although a simple relation between the concentration of acid and the rise of the capacity was not found, there is a semi-logarithmic relation between the concentration of sodium hydroxide and the capacity. Only Na-form exchanger and Natural- and H-form can be used in column for the removal of strontium. It was concluded that Natural-form bentonite has selectivity for cesium ion as the result of very low capacity for strontium comparing with cesium. However, montmorillonite possibly has a high capacity for strontium corresponding to cesium in the treatment with sodium hydroxide. (auth)

12100 VIBRATIONAL SPECTRA OF DEUTERIUM AND TRITIUM SUBSTITUTION PRODUCTS OF NON-LINEAR TRIATOMIC HYDRIDES. V. P. Morozov, N. T. Kvasha, A. Ya. Tsaune, and V. A. Lisovenko. Opt. Spectry. (USSR) (English Transl.), 15: 335-7(Nov. 1963).

A vibrational spectrum calculation was carried out for triatomic nonlinear hydrides of the type H_2R (R = O, S, Se) and their deuterium and tritium substitution products in the gas phase. Allowance for anharmonicity of the vibrations was made by the method of spectroscopic masses. The force constants and interaction coefficients of these molecules were computed. (auth)

12101 ISOTOPE SHIFTS IN THE URANIUM SPECTRUM. P. Ramakoteswara Rao (Atomic Energy Establishment, Trombay, India). Proc. Indian Acad. Sci., Sect. A, 58: 353-61(Dec. 1963).

Isotope shifts in over twenty lines of UI spectrum excited in a hollow cathode discharge, in the region 5200t to 6000 Å, were recorded on a spectrometer equipped with a photoelectric detector. The results were used to check line classification. (P.C.H.)

12102 D_2O EFFECT ON $\Delta H^{\ddagger}$ AND $\Delta S^{\ddagger}$ IN THE $IRON^{II}$–$IRON^{III}$ ELECTRON-EXCHANGE REACTION. Shouzow Fukushima and Warren L. Reynolds (Univ. of Minnesota, Minneapolis). Talanta, 11: 283-93(Feb. 1964).

The equilibrium constant of the reaction $Fe^{3+} + D_2O \rightarrow FeOD^{2+} + D^+$ was measured at 0.500 ionic strength at 5, 15, and 25°C. The ΔH and ΔS of this reaction are 9.32 ± 0.56 kcal $mole^{-1}$ and 17.7 ± 2.0 cal deg^{-1} $mole^{-1}$, respectively. The rates of the electron-exchange reactions $Fe^{2+} + {}^*Fe^{3+} \rightarrow Fe^{2+} + {}^*Fe^{2+}$ and $Fe^{2+} + {}^*FeOD^{2+} \rightarrow FeOD^{2+} + {}^*Fe^{2+}$ were measured at 0.500 ionic strength at 5, 15, and 25°C. The enthalpy and entropy of the latter reaction are 11.5 ± 0.5 kcal $mole^{-1}$ and −4.0 ± 1.8 cal deg^{-1} $mole^{-1}$, respectively. (auth)

12103 LOCALIZED MODES OF VIBRATIONS IN IONIC CRYSTALS WITH AN ISOTOPIC DEFECT. G. S. Zavt and N. N. Kristoffel. Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR, No. 23, 3-17(1963). (In Russian)

An equation for the determination of the frequencies of localized modes of vibrations generated by an isotopic impurity in ionic crystals of NaCl-type was obtained by the Green functions method in harmonic approximation. It is shown that for the build-up of the vibrations of localized modes in lattices with similar values of ion masses, the impurity must be on an average twice lighter than the substituted ion. Dependence of the localized mode frequency on the impurity mass was investigated in detail for NaF. The frequencies of localized modes of vibrations of U-centers of H^- and D^- types for ten ionic lattices were computed. The results of calculations are in agreement with the experimental data available. (auth)

12104 BAND SPECTRA OF CRYSTALS ACTIVATED WITH MERCURY-LIKE IONS. [PART] I. Ch. B. Lushchik, N. E. Lushchik, and I. A. Muuga. Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR, No. 23, 22-37(1963). (In Russian)

The shapes of emission and excitation spectra of KCl–Bi, $Ca_3(PO_4)_2$–Bi, CaO–Bi, and CaS–Bi phosphors were investigated at 295 and 100°K. The phosphors with great Stokes losses (KCl–Bi) have continuous spectra of emission and excitation. Those with relatively small Stokes losses (CaO–Bi) reveal at 100°K series of marked equidistant sharp bands on the background of continuous emission and excitation spectra. Mercury-like centers with small Stokes losses may serve as convenient luminescent probes for the investigation of the vibrational processes in solids. (auth)

12105 POLARIZED LUMINESCENCE OF THE MERCURY-LIKE CENTERS IN ALKALI HALIDE CRYSTALS. [PART] II. S. G. Zazubovich. Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR, No. 23, 38-60(1963). (In Russian)

Polarization spectra, azimuthal dependences of the degree of polarization, dependences of the polarization degree on the frequency of the emission, and the polarization diagrams of luminescence of KCl–Sn, KBr–Sn, and KI–Sn were measured at 295 and 100°K. The nature of elementary absorptive and emissive oscillators (both linear and circular) was established from an analysis of the polarization characteristics. The activator absorption bands are shown to be correlated with the electron transitions $^1S_0 \rightarrow {}^3P_1$, $^1S_0 \rightarrow {}^3P_2$, $^1S_0 \rightarrow {}^1P_1$, and the emission band corresponds to transitions $^3P_1 \rightarrow {}^1S_0$ in Sn^{2+} ions that are imbedded in a crystal field of tetragonal symmetry. (auth)

12106 THE EFFECT OF PRESSURE ON THE EMISSION SPECTRA OF THE FLUORITE CRYSTALS ACTIVATED WITH THE RARE-EARTH IONS Sm^{3+} AND Eu^{3+}. A. N. Laisaar. Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR, No. 23, 67-77(1963). (In Russian)

The effect of hydrostatic pressure up to 6000 kg/cm^2 on some emission lines of the phosphors CaF_2–Sm^{3+} and CaF_2–Eu^{3+} was investigated. It was established that in fluorite activated with samarium, both of the investigated lines at 15338 cm^{-1} (6520 Å) and at 16548 cm^{-1} (6043 Å), are shifted at 6000 kg/cm^2 toward longer wavelengths, namely by 6.1 and 6.0 cm^{-1}, respectively. In fluorite activated with europium, the line at 15849 cm^{-1} (6310 Å) shifts 3.9 cm^{-1} to longer wavelengths, the line at 16217 cm^{-1} (6166 Å) shifts 3.0 cm^{-1} to shorter wavelengths, whereas the line at 17436 cm^{-1} (5735 Å) does not show practically any detectable shift. Possible mechanisms of the spectral shifts connected with intensification of the crystal field under the action of pressure are discussed. (auth)

12107 CATHODOLUMINESCENCE OF PHOSPHORS ACTIVATED WITH MERCURY-LIKE IONS. T. I. Eksina. Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR, No. 23, 189-99(1963). (In Russian)

Cathodoluminescence of a number of alkali halide crystals (KCl, KBr, KI, RbI, CsI) and $Ca_3(PO_4)_2$ activated with mercury-like ions Ga^+, Ge^{2+}, In^+, Sn^{2+}, and Tl^+, as well as of unactivated host crystals was studied. The mercury-like luminescence centers in the phosphors can easily be excited with an electron beam. The experimental results clearly show the appearance of activator emission in cathodoluminescence of the phosphors. The spectrum of the emission is very close to (if not identical with) the fluorescence spectrum; the emission under electron excitation corresponds to $^3P_1 \rightarrow {}^1S_0$ transitions in Ga^+-, Ge^{2+}-, In^+-, Sn^{2+}-, and Tl^+-centers. Dependence of cathodoluminescence spectra on the activator concentration in the surface layer of KI–Tl was examined. Possible mechanisms of cathodoluminescence of the phosphors are considered. (auth)

12108 REFLECTANCE SPECTRA OF NON-STOICHIOMETRIC TITANIUM OXIDE, NIOBIUM OXIDE, AND VANADIUM OXIDE. F. Vratny (Bell Telephone Labs., Murray Hill, N. J.) and F. Micale. Trans. Faraday Soc., 59: 2739-49(Dec. 1963).

The diffuse reflectance spectra were obtained for non-stoichiometric titanium oxide, niobium oxide, and vanadium oxide in the spectral region from ~330 mμ to ~1300 mμ. The spectra are interpreted in terms of changes in the ultraviolet cut-off and changes in the visible reflectance. Data are given for the effect of composition on the effective band gap of these oxides. (auth)

12109 A STUDY OF THE SEDIMENTATION OF FLOCCULATED THORIA SLURRIES USING A GAMMA-RAY TECHNIQUE. H. A. Kearsey and L. E. Gill (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Trans. Inst. Chem. Engrs. (London), 41: 296-306(Oct. 1963).

The settling of three different flocculated slurries of thoria at different concentrations was studied with a radiographic technique whereby the variation in concentration with time and position in the settling beds could be determined. The slurries underwent either hindered settling or compaction according to their initial concentration. The Kozeny equation was found to apply to hindered settling only at low concentrations. During hindered settling, turbulences occurred giving the bed the appearance of being fluidized. In compaction settling, increases in concentration occurred at both the top and bottom of the bed. Values of yield stress were obtained, which were consistent with those previously reported in rheological studies. (auth)

12110 THE CHEMISTRY OF THE LANTHANIDES. Therald Moeller. Selected Topics in Modern Chemistry. New York, Reinhold Publishing Corporation, 1963. 124p. $1.95.

Information is presented on the history of the lanthanides; atomic structure and its consequences; oxidation states; occurrence, recovery, separation, and application; and the actinides–a related series. (P.C.H.)

12111 THE ANOMALOUS HEAT CAPACITY OF SOLID DEUTERIUM. (33.1—872% PARA). George Ernest Grenier. Thesis, Columbus, Ohio, Ohio State Univ., 1963. 96p.

The anomalous heat capacities were measured from 1.5°K to the triple points for solid D_2 in the composition

range 33.1 to 87.2% para. The anomalies above 64.6% para content were sharp transitions, while the anomalies in the samples of lower para content were broad 'humps.' The temperatures for the sharp transitions were linear with para concentration. The heat capacity for liquid D_2 of 78.7% para content showed no significant variation from the heat capacity of liquid ortho D_2. The heat capacity of solid HD was measured from 2.5°K to its triple point. The heat of fusion of D_2 at its triple point averaged to 47.19 ± 0.07 cal/mole. Triple points of 18.781°K and 18.787°K were measured for 75.1% and 85.0% para D_2, respectively. The rate of para to ortho conversion in solid D_2 was found to be first order with respect to para concentration, with the rate constant being approximately 1.10^{-3} hr^{-1}. The third law entropy of the gas was compared with the calculated statistical entropy for the HD and D_2 samples, and values of 0.06 eu for HD and 0.06 to 0.09 eu for D_2 were obtained. The excellent agreement for D_2 indicates that the anomaly arises from the removal of the 3-fold degeneracy of the J = 1 level. A cooperative mechanism initiated by quadrupolar interactions was proposed for removal of the rotational degeneracy. The heat capacities of solid D_2 above 15°K are divided into 2 classes of curves. Curves for para concentration of less than 50% merge with the curve for ortho D_2, while the heat capacities for higher para concentrations have a different common curve. This could be caused by a difference in lattice dimensions or by 2 different crystal structures, if the 2 curves can be considered to be due only to lattice vibrations. (M.P.G.)

12112 CRUCIBLE-FREE SYNTHESIS OF SILICIDES AND BORIDES. Z. Ban and M. Sikirica (Institut "Rudjer Boskovic," Zagreb). p.175-82 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. II." Vienna, International Atomic Energy Agency, 1963.

A laboratory method for preparing pure silicides and borides by reducing the corresponding oxides of metals was developed. Synthesis of silicides was carried out in the floating zone of molten silicon. The floating zone was obtained by means of electron bombardment. Synthesis of borides is similar but reactions are generally of the solid-solid type. Initial heating of the reaction mixture was also obtained by means of the electron beam but further heating was produced by the ionized gaseous products of the reaction. (auth)

12113 RELATION BETWEEN IONIC RADII AND TRANSFORMATION TEMPERATURE IN RARE EARTH NIOBATES. K. A. Gingerich and H. E. Bair (Pennsylvania State Univ., University Park). 18p. (CONF-174-9)

From 12th Annual Conference Application of X-Ray Analysis, Denver, Aug. 1963.

A high temperature x-ray diffraction study was made on rare earth niobates (Ce, La, Nd, Gd, Ho, Y, Tm, Yb) in order to obtain a more detailed understanding of the nature of the reversible temperature transformation between reported monoclinic and tetragonal forms. The temperature range over which the gradual transformation occurs was determined accurately. Also, the rate of the changes and their reversibility were observed, and the influence of substitution of the rare earth cation on the transformation was studied. For all eight niobate compounds studied, it was found that the high-low transformation over the whole temperature range from monoclinic at room temperature to tetragonal at the transition temperature was a continuous process in which each intermediate monoclinic state attained equilibrium within a few minutes of reaching a new temperature plateau. Data are tabulated. (P.C.H.)

12114 APPARATUS FOR OBTAINING METAL FLUORIDES. Jovino Diaz Pedregal and Francisco Aquilar Bartolome (to Junta de Energie Nuclear). British Patent 949,951. Feb. 19, 1964. Filed Nov. 4, 1960.

An apparatus was developed for preparing metal fluorides by reaction of the metal with gaseous fluorinating agents. The apparatus consists of a shaft-like vertically arranged reaction vessel that has connected to it a supply and discharge chamber. The chambers are provided with inlets for an inert gas under pressure and have gas-tight valves. (M.C.G.)

12115 PROCESS FOR RECOVERING THE CATALYST IN AN INSTALLATION FOR THE ENRICHMENT OF AMMONIA IN DEUTERIUM. (to Commissariat a l'Energie Atomique). British Patent 950,200. Feb. 19, 1964. Priority date Aug. 6, 1959, France.

A process was developed for recovering the catalyst in an installation for enrichment of ammonia in deuterium by isotopic exchange between hydrogen and liquid ammonia in the presence of an alkali metal amide catalyst. The enriched ammonia containing amide catalyst or an aqueous extract thereof is electrolyzed in an electrolyzer having alkali metal amalgam as the cathode so as to transfer the alkali metal of the amide to the amalgam. Then the amalgam is used as the anode in a second electrolyzer containing as the electrolyte ammonia of lower deuterium concentration than the enriched ammonia, so that the alkali metal passes from the amalgam into the ammonia of lower deuterium concentration. The formation of alkali metal amide is catalyzed either in this electrolyzer or in a separate receiver. The resulting solution of amide in ammonia is used for isotopic exchange. (M.C.G.)

12116 APPLICATION OF SOLS OF HYDRATED ACTINIDE OXIDE AS NUCLEAR FUEL. Thomas L. O'Conner, Walter Juda, Paul H. McNally, and Norman W. Rosenberg (to Diamond Alkali Co.). German Patent 1,156,179. Oct. 24, 1963. Priority date Nov. 12, 1959, United States.

The application of sols of hydrated actinide oxide as nuclear fuel is proposed. The particle size varys between 10 and 100 μ. At least 50% of the sols have a particle diameter that doesn't deviate more than 30% from the average particle diameter. The pH range is 3 to 9, preferably 3 to 6.5. (Gmelin Inst)

12117 REDUCTION OF URANIUM OXIDE. Robert J. Teitel (to Dow Chemical Co.). U. S. Patent 3,119,686. Jan. 28, 1964. Filed Aug. 17, 1960.

A method is described for the separation of uranium and magnesium oxide in a zinc alloy medium from the magnesium reduction of uranium oxide. The process involves settling separation of the magnesium oxide and the uranium–zinc intermetallic compound formed in the contacting of uranium oxide with a molten magnesium–zinc mixture. The uranium–zinc compound is then heated to affect distillation of magnesium and zinc from metallic uranium. (R.E.U.)

12118 PROCESS OF PREPARING URANIUM CARBIDE. William E. Miller, Howard L. Stethers, and Terry R. Johnson (to U. S. Atomic Energy Commission). U. S. Patent 3,123,435. Mar. 24, 1964.

A process of preparing uranium monocarbide is described. Uranium metal is dissolved in cadmium, zinc, cadmium–zinc, or magnesium–zinc alloy and a small quantity of alkali metal is added. Addition of stoichiometric amounts of carbon at 500 to 820°C then precipitates uranium monocarbide. (AEC)

12119 PREPARATION OF PuF_3. Robert Benz (to U. S. Atomic Energy Commission). U. S. Patent 3,123,436. Mar. 3, 1964.

A process for preparing pure plutonium trifluoride is described in which a refractory plutonium compound is contacted with ammonium fluoride in a closed container at a pressure of at least 10 atmospheres and a temperature of about 550°C. (AEC)

12120 GRAPHITE PRODUCTION UTILIZING URANYL NITRATE HEXAHYDRATE CATALYST. Haskell Sheinberg, John R. Armstrong, and Donald H. Schell (to U. S. Atomic Energy Commission). U. S. Patent 3,124,625. Mar. 10, 1964.

The graphitizing of a mixture composed of furfuryl alcohol binder and uranyl nitrate hexahydrate hardener and the subsequent curing, baking, and graphitizing with pressure being initially applied prior to curing are described. The pressure step may be carried out by extrusion, methyl cellulose being added to the mixture before the completion of extrusion. Uranium oxide may be added to the graphitizable mixture prior to the heating and pressure steps. The graphitizable mixture may consist of discrete layers of different compositions. (AEC)

Organic Chemistry

12121 (AEET/CD/16) CRYSTALLOGRAPHIC STUDIES ON H[Sm EDTA] H_2O AND H[Er EDTA]. V. Amirthalingam (India. Atomic Energy Establishment, Trombay). 1963. 5p.

Preliminary x-ray powder and single-crystal data are presented for H [Sm EDTA] H_2O and H [Er EDTA]. For H [Sm EDTA] H_2O, the cell dimensions are a = 11.59 A and c = 36.6 A, the number of molecules/unit cell Z = 12, density = 1.89 g/cm^3, and space group = $I4_{1/a}$. For H [Er EDTA], a = 11.74 A, b = 5.96 A, c = 12.11 A, β = 100°30′, Z = 2, density = 1.84 g/cm^3, and space group = Pn. (D.L.C.)

12122 (AERE-M-913) CONCERNING POSSIBLE HYDROATACTIC ORGANO-PHOSPHORUS POLYMERS. J. A. Cade (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Aug. 17, 1960. 8p.

In the future, materials will be demanded which possess both good constructional and functional properties. Existing organo-phosphorus polymers are prevented from fulfilling this demand owing to P–O–C brides which make them susceptible to hydrolysis, pyrolysis, and radiolysis. A discussion is presented of some ideas on the problem of producing an organo-phosphorus polymer containing only P–C bonds. The application of the Arbuzov-Michaelis rearrangement to a chain process is discussed, and the polymer properties to be expected are described. (D.L.C.)

12123 (IA-906) SELECTIVITY EFFECTS IN RECOIL LABELING OF METHYL IODIDE BY FISSION-PRODUCED IODINE. Yehuda Paiss and Saadia Amiel (Israel. Atomic Energy Commission. Soreq Research Establishment, Nahal Soreq). Oct. 1963. 6p.

Recoil labelling of methyl iodide by fission produced iodine isotopes was observed to be of higher efficiency with independently produced iodine, than with the same isotopes recoiling from β decay. (auth)

12124 (PA-TM-1167) THE PREPARATION OF CARBON-14 LABELED TETRAMETHYLAMMONIUM BROMIDE. Andrew F. Smetana, Jerome Haberman, and Thomas C. Castorina (Picatinny Arsenal, Dover, N. J.). Apr. 1963. 16p.

Carbon-14 labeled tetramethylammonium bromide was prepared via the condensation of C^{14} methyl bromide with trimethylamine using high vacuum techniques. Unrecrystallized product yields, in the range of 100% of theory (based on methyl bromide), are independent of variations in excess quantities of trimethylamine. C^{14} methyl bromide is effectively derived from an intermixture of C^{14} methyl iodide with methyl bromide in the ratio of 1:350. A series of preparations from aliquots of the stock CH_3^*I/CH_3Br mixture result in reproducible yields and specific activities of 1.8% average deviation. (auth)

12125 (TID-20123) QUARTERLY PROGRESS REPORT NO. 11 [ON CHEMICAL RESEARCH], NOVEMBER 15, 1963. (Ethyl Corp. Research and Development Dept., Detroit). Contract AT(11-1)-999. 7p.

Tricyclopentadienyluranium methoxide and butoxide were prepared with the generic formula $(C_5H_5)_3U \cdot OR$. Similar alkoxides of thorium, $(C_5H_5)_3Th \cdot OR$ were also prepared. These alkoxides are made most readily by treating the tetrachlorides of uranium or thorium with an equivalent of the desired sodium alkoxide followed by three equivalents of cyclopentadienylsodium. Dicyclopentadienylrhenium hydroxide was found to be inert toward unsaturated systems such as 3-hexyne and acetylene at temperatures in the region of 70°C. At higher temperatures, 100 to 150°C, unresolvable resinous products were formed. Dimethylacetylene dicarboxylate reacted readily with the hydride at room temperature with the formation of a red crystalline 1:1 adduct of the reactants. This adduct is believed to be a dicyclopentadienylrhenium-substituted dimethylmaleate. (auth)

12126 GEMINAL H,D SPIN-SPIN COUPLING AND ISOTOPE EFFECTS IN PARTIALLY DEUTERATED METHYL-AROMATIC COMPOUNDS. C. G. MacDonald, J. S. Shannon, and S. Sternhell (Commonwealth Scientific and Industrial Research Organization, Chatswood, New South Wales). Australian J. Chem., 17: 38-46(Jan. 1964).

Seventeen methyl-aromatic compounds were selectively, partially deuterated by catalytic hydrogen exchange. The proton magnetic resonance (pmr) spectra of the partially deuterated compounds showed that the geminal H,D coupling constant is approximately 2.2 c/s and that it does not vary significantly with the type of substitution in the ring. The deuterium isotope effect on the chemical shift of the remaining protons in the methyl group is approximately 0.7-1.1 c/s in the upfield direction for the introduction of one deuterium atom. (auth)

12127 CONCERNING THE ROLE OF PROTONATED CYCLOPROPANE INTERMEDIATES IN SOLVOLYTIC REACTIONS. I. THE SOLVOLYSIS OF CYCLOPROPANE IN DEUTERIOSULFURIC ACID. Richard L. Baird and Akintola A. Aboderin (Yale Univ., New Haven). J. Am. Chem. Soc., 86: 252-5(Jan. 20, 1964).

The solvolysis of cyclopropane in 8.4 M sulfuric acid solutions leads to 1-propanol (and its acid-sulfate) as the only important products. In deuteriosulfuric acid, deuterium is incorporated into all three positions of the 1-propanol carbon skeleton, although control experiments indicate that no scrambling of deuterium occurs either before or after solvolysis of the cyclopropane. The implications of this observation are discussed and a mechanism involving protonated cyclopropane intermediates is proposed to account for it. (auth)

12128 MASS SPECTROMETRY IN STRUCTURAL AND STEREOCHEMICAL PROBLEMS. XLI. ISOTOPE EFFECT

IN HYDROGEN REARRANGEMENT PROCESSES: THE MASS SPECTRA OF METHYL BUTYRATE AND ITS γ-MONO-, DI-, AND TRIDEUTERIO ANALOGS. D. H. Williams, H. Budzikiewicz, and Carl Djerassi (Stanford Univ., N. J.). J. Am. Chem. Soc., 86: 284-7(Jan. 20, 1964).

The mass spectra of methyl butyrate and its γ-mono-, di-, and trideuterio analogs were measured and an isotope effect corresponding to a transfer of 0.88 atom of deuterium per atom of hydrogen in a specific rearrangement process was observed. It is speculated that this effect is probably also operative in many related γ-hydrogen rearrangements observed in mass spectrometry. (auth)

12129 DETERMINATION OF MOLECULAR WEIGHTS OF POLYNUCLEAR ZIRCONIUM AND THORIUM CHELATES BY NONEQUILIBRIUM ULTRACENTRIFUGATION. Richard L. Gustafson and Arthur E. Martell (Clark Univ., Worcester, Mass. and Illinois Inst. of Tech., Chicago). J. Am. Chem. Soc., 86: 344-9(Feb. 5, 1964).

The degrees of aggregation of 1:1 Th(IV)–N-hydroxyethylethylenediamine triacetate (HEDTA), 1:1:1 Th(IV)–HEDTA–pyrocatechol 3,5-disulfonate (Tiron), 1:1 Zr(IV)–HEDTA, and 1:1:1 Zr(IV)–ethylenediamine tetraacetate (EDTA)–Tiron chelates were calculated from data obtained by nonequilibrium centrifugation in sodium chloride solutions at 25°. The 1:1 Th(IV)-HEDTA chelate is shown to be most probably hexameric, whereas solutions containing equimolar amounts of Th(IV), HEDTA, and Tiron to which have been added 4½ and 6.0 moles of sodium hydroxide per mole of metal ion were found to be polydisperse. Solutions of Zr(IV) and HEDTA at pH 6 were found to be composed of mixtures of monomers and dimers. A value of $K_D = [\text{dimer}]/[\text{monomer}]^2 = 10^{2.14}$ was obtained from the sedimentation data. The data obtained for the 1:1:1 Zr(IV)–EDTA–Tiron systems at pH 7 suggest that a mixture of monomers and dimers is present. (auth)

12130 INFRARED SPECTRA OF GASEOUS DIAZOMETHANE. C. Bradley Moore and George C. Pimentel (Univ. of California, Berkeley). J. Chem. Phys., 40: 329-41(Jan. 15, 1964).

The gaseous infrared spectra of CH_2N_2, $CHDN_2$, CD_2N_2, and $CH_2N^{15}N$ were examined between 230 and 4000 cm^{-1} under medium resolution. Band positions were measured for all the distinguishable parallel features. Nearly all of the perpendicular fundamentals were resolved and analyzed. The $[A'' - \frac{1}{2}(B'' + C'')]$ rotational constants derived are: $CH_2N^{15}N$, 8.747 ± 0.015 cm^{-1}; CD_2N, 4.253 ± 0.01 cm^{-1}; $CHDN_2$, 5.72 ± 0.1 cm^{-1}. These data combined with that given earlier for the CH_2N_2 isotope, show that the averaged distance of the hydrogen atoms from the molecular axis (in CH_2N_2 and in $CH_2N^{15}N$) is 0.9580 ± 0.0006 Å and of the deuterium atoms (in CD_2N_2) is 0.9560 ± 0.001 Å. In contrast to earlier studies, no evidence was found for the presence of a tautomeric form of diazomethane in the samples studied. (auth)

12131 SOLID INFRARED SPECTRA, ASSIGNMENT AND VIBRATIONAL POTENTIAL FUNCTION OF DIAZOMETHANE. C. Bradley Moore and George C. Pimentel (Univ. of California, Berkeley). J. Chem. Phys., 40: 342-55(Jan. 15, 1964).

Infrared spectra of pure solid diazomethane and diazomethane in nitrogen or argon are given for the molecules CH_2N_2, CD_2N_2, $CHDN_2$, and $CH_2N^{15}N$. These data combined with the gas-phase spectra reported earlier provide a basis for a reassignment of the vibrational spectrum. The vibrational potential function, centrifugal distortion constants, Coriolis coupling constants, and thermodynamic functions of diazomethane were calculated. The out-of-plane hydrogen bending force constant was found to be unusually low, 0.045×10^{-11} erg rad^{-2}. This is about one-fifth of that for ethylene and about one-half of that for ketene. The observed divergence of the energy levels of the out-of-plane hydrogen bending mode shows that there must be a large positive quartic contribution to the potential function for this motion. (auth)

12132 PROTON MAGNETIC RESONANCE OF SEVERAL NEW CHELATES. J. R. Ferraro (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 26: 225-30(Feb. 1964).

The proton magnetic resonance spectra of several new chelates of the type $M(TTA)_a \cdot bS$, where TTA is monoionized thenoyltrifluoroacetone, and S is a neutral organophosphorus ester, were determined. The metal ring proton resonance is found about 0.4 – 1.2 ppm upfield from that in benzene, and 0.8 – 1.6 ppm downfield from that in metal acetylacetonates. This is a consequence of the electronegativity of the thenoyl- and CF_3-groups in TTA, and the possible resonance between the thenoyl and the chelate rings. (auth)

12133 REACTIONS OF DEUTERIUM ATOMS WITH OLEFINS IN LIQUID PROPANE AT 90°K. RELATIVE RATE CONSTANTS OF THE ADDITION. T. T. Kassal and M. Szwarc (Syracuse Univ., N. Y.). J. Phys. Chem., 68: 381-4(Feb. 1964).

The addition of D atoms to a series of olefins and dienes was studied at 90°K. The deuterium atoms were formed on a hot tungsten wire in the gas phase and thereafter diffused into liquid propane where a homogeneous reaction took place. The relative rate constants of D atom addition to propylene, butene-1, pentene-1, hexene-1, and 3-methylbutene-1 were found to be nearly identical, the addition to isobutene and butadiene were found to be 5 and 25 times faster than to the terminal olefins, while the addition to pentene-2 and hexene-2 were half as high. Allene was found to be less reactive than the internal olefins. The usual pattern of reactivities is maintained even at this low temperature. (auth)

12134 SPECTROPHOTOMETRIC STUDIES ON THE CHELATE FORMATION BETWEEN URANIUM(VI) AND 1-(O-ARSONOPHENYLAZO)-2-NAPHTHOL-3,6-DISULFONATE (THORON) IN AQUEOUS SOLUTION. Satendra P. Sangal and Arun K. Dey (Univ. of Allahabad, India). J. Prakt. Chem., 20: 219-24(1963).

Three different methods, continuous variations, mole ratio, and slope ratio, were used to establish the composition of the Thoron chelate. Mixtures containing uranyl sulfate and Thoron in different stoichiometric ratios (0:1, 1:0.5, 1:1, 1:2, 1:3) were prepared and the absorbances measured. The observations showed that the wavelength of max absorbance of Thoron lies at 485 mμ, whereas the case of mixtures the λ_{max} shifts to 510 mμ. Thus it is clear that only one chelate having λ_{max} at 510 mμ is formed under these conditions. The results of the continuous variations method showed that the composition of the chelate is UO_2 (Thoron), and this composition was further confirmed by the mole ratio and slope ratio methods. When the absorbances of mixtures containing uranyl sulfate and Thoron in the ratio 1:1 at different pH were measured at various wavelengths, it was found that the λ_{max} of the chelate (510 mμ) holds from pH 2.5 to 5.0, indicating that the chelate is stable within this pH range. The maximum color intensity of the chelate at its λ_{max} remains constant between pH 2.5 and 4.0. The donor properties of the azo group are weak, but azo compounds that contain a strong donor group in a

position ortho to the azo group form very stable chelate rings. In Thoron there are the hydroxy group and an arsonic group in ortho position to the azo group, which makes it effective as a chelating agent. Both these groups are capable of linking the metal ion by the removal of a proton. When the chelate was studied at pH 3.0, the sulfonic acid groups were not ionized; thus the chelate would be neutral. This was confirmed by passing the chelate through columns of ion-exchange resins; neither H (IR 45) nor OH (IR 120) varieties of Amberlite absorbed the chelate. (TCO)

12135 MASS SPECTROMETRY IN STRUCTURAL AND STEROCHEMICAL PROBLEMS. XXIII. SOME OBSERVATIONS ON THE MASS SPECTRAL FRAGMENTATION OF Δ^1- AND Δ^4-3-KETO STEROIDS. R. H. Shapiro, J. M. Wilson, and Carl Djerassi (Stanford Univ., Calif.). Steroids, 1: 1-6(Jan. 1963).

α,β-Unsaturated ketones, such as Δ^1- and Δ^4-3-keto steroids, exhibit a characteristic mass spectral peak in the high mass range at M-42, corresponding to the loss of the carbonyl function and the adjacent methylene grouping. This characteristic feature was confirmed by deuterium labeling, during the course of which the unexpected observation was made that D exchange of Δ^1-3-keto steroids leads to the introduction of 3, rather than the expected 2 D atoms. A comparison of the nuclear magnetic resonance (NMR) spectra of the deuterated and nondeuterated ketones showed that the latter exhibited a 2-proton signal at 2.22 ppm, corresponding to the 2 hydrogen atoms attached to C-4 as well as doublets (J = 10 cps) centered at 5.85 and 7.15 ppm, associated with the C-2 and C-1 olefinic protons. The NMR spectrum of the deuterated ketone lacked the 2.22 and 5.85 signals, but showed a singlet at 7.15 ppm, thus proving rigorously that the 3rd D atom had entered at carbon atom 2. A plausible explanation for the D introduction is given. It is pointed out, however, that caution has to be exercised in utilizing such D equilibration experiments for establishing the number of exchangeable H atoms in α,β-unsaturated ketones fully substituted in the γ-position. (TCO)

12136 PART ONE: A STUDY OF UNIMOLECULAR GAS PHASE REACTIONS NEAR THE LIMITING FIRST ORDER REGION. PART TWO: THE HYDROGEN ISOTOPE EFFECT IN THE THERMAL DECOMPOSITION OF CYCLOBUTANE. Robert Wilson Carr, Jr. Thesis, Rochester, N. Y., Univ. of Rochester, 1963. 137p.

The thermal decomposition of cyclobutane and the thermal isomerization of cyclobutene were investigated at pressures greater than those at which the first-order rate constants begin to fall appreciably from their high pressure limit. The thermal decomposition of cyclobutane at pressures up to 1500 mm Hg over the temperature range 418 to 460°C was found to be a first order, homogeneous process yielding ethylene as the only product of any significance. At 449°C the experimental first-order rate constants for the decomposition do not change detectably with pressure from 100 to 1500 mm Hg, showing that the high pressure limit of this reaction was essentially reached. The activation energy with 650 to 1500 mm Hg initial pressure was found to be 62.5 ± 0.4 kcal/mole. The experimentally determined rate constant at 650 to 1500 mm Hg is representative of the high pressure limit and may be expressed as $k = 4.24 \times 10^{15} \exp(-62{,}500/RT)\ sec^{-1}$. At 1500 mm Hg the thermal isomerization of cyclobutene produces 1,3-butadiene by a first-order process, which is free of significant side reactions. Rate measurements over the range from 50 to 1500 mm Hg at both 150°C and 175°C indicated that the increase in initial pressure produces very little change in the first-order rate constants in this region. The temperature dependence of the isomerization was studied at pressures near 100 and 1500 mm Hg. The activation energy was observed not to change over this pressure range, and the value at the high pressure limit is most probably 32.6 ± 0.5 kcal/mole. The thermal decomposition of mixtures of cyclobutane and cyclobutane-d_8 was studied. The value of the isotope effect (k_H/k_D) at 449°C and 100 mm Hg is 1.39. The isotope effect is pressure dependent. The ratio (k_H/d_D) reaches a value of unity near 0.1 mm Hg, and at even lower pressures an inverse isotope effect was observed. The temperature dependence of the isotope effect can be expressed as $k_H/k_D = 0.45 \exp(1600/RT)$. (M.P.G.)

12137 SYNTHESIS OF HEXOSE PHOSPHATE SPECIFICALLY LABELED WITH C^{14}. Samuel Koorajian. Thesis, Chicago, Univ. of Illinois, 1962. 67p.

The chemical and enzymatic synthesis of a hexose specifically labeled with C^{14} in the C_4 position is reported. The starting material in the synthesis was DL-serine-1-C^{14}. The product fructose-1,6-diphosphate-C^{14} was isolated as the barium salt and identified enzymatically and chromatographically on paper. The position of the isotope in D-fructose-1,6-diphosphate-C^{14} was determined by 2 methods. It was found that C_3 contained 30% of the isotope and the remainder of the molecule contained 70% of the isotope (C_4 was assumed to contain the isotope responsible for the radioactivity in the remainder of the molecule). The randomization of the label cannot be explained by any known biochemical or chemical pathways or mechanisms assuming the absence of triosephosphate isomerase. (M.P.G.)

Radiation Chemistry and Radiochemistry

Refer also to abstract 12517.

12138 (BM-RI-6382) PRELIMINARY STUDY OF INORGANIC REACTIONS IN A HIGH-GAMMA RADIATION FLUX. J. E. Tress, C. E. Wicks, and F. E. Block (Bureau of Mines. Albany Metallurgy Research Center, Ore.). June 1963. 19p.

An investigation was conducted of the effects of gamma radiation on materials and chemical reactions to obtain information that could be of value in modern metallurgical practices. Various combinations of metals and their ores and compounds were irradiated in attempts to effect reactions that might be applicable in the extraction and separation of metal values from minerals and ores. The types of reactions studied included complexing of salts, decomposition of hydrated salts, metal chlorination reactions, leaching of ores and minerals, halogen exchange, and various reducing reactions. All irradiations were performed at the Materials Testing Reactor Gamma Facility. Spent fuel elements were utilized as the source of the gamma radiation. Some irradiation-induced changes, ranging from mere color change to participation in chemical reactions, were noted. The greatest value of these investigations, however, was the experience acquired, which should be valuable in future explorations of similar nature. (auth)

12139 (BNL-823(p.48-56)) RADIATION DIVISION. B. Manowitz (Brookhaven National Lab., Upton, N. Y.).

Construction work performed in the High Intensity Radiation Development Laboratory (HIRDL) included installation of a complete conveyer system and a stainless steel

lining for the entire HIRDL canal system. In gamma irradiation service and operations, encapsulation of a number of flat Co^{60} sources was made. In the radiation engineering program, measurement of the effect of a finite air-water plane interface on the buildup factor indicated a 10% decrease compared to an infinite system. A Monte Carlo machine program for energy deposited in a cylindrical target was computed and a paper study was prepared on unfolding the gamma spectrum from a Co^{60} source. In experimental studies on electrical charge buildup in bulk shielding glass, color center measurements of Ce-protected glass indicated color saturation at a total dose of 1×10^7 rad. Equipment designs were prepared for making calorimetric measurements of the self-absorption in the radiation sources. A program for studying corrosion and radiation damage of Al and stainless steel encapsulated sources was initiated. Conceptual design studies of a shipboard fish irradiator and a grain irradiator were completed. Construction and installation of a temporary gamma irradiation facility for performing high pressure and low temperature studies in the Radiation Processing program are nearing completion. The characterization and evaluation of radiation-produced polyethylene in the annealed state indicated that the density and tensile strength decreases with increasing total dose. In studies on the copolymerization of ethylene with chlorotrifluoroethylene (CTFE), the concentration of CTFE and dose rate was found to strongly influence the initiation of an explosive decomposition in this system by a radiation field. Survey experiments were begun on the possibility of copolymerization of Si compounds with ethylene. Polymerization in monomer impregnated wood and paper was also carried out. The effect of Co^{60} and pile radiation on polyethylene for determining a possible radiation equilibrium composition is being studied. The radiolysis of anhydrous liquid ammonia indicated a steady-state concentration of 1.2×10^{-4} mole/liter of hydrazine. A back reaction with H_2 is believed to destroy the N_2H_4. In the program on heterogeneous radiation chemistry, the decomposition of CO_2 on various solid substrates is being investigated. Theoretical and experimental studies on the design of reaction vessels for the production of chemicals by radiation chemical reactions are being carried out. Initial efforts were concerned with intermittent irradiation, non-uniform dose rate distribution, and mixing in the reaction vessel. In the program on Chemonuclear Reactors, the fabrication of the full-scale mock-up of the in-pile research loop was begun. A review of the aerodynamic and thermal characteristics of the loop was made and procurement of major pieces of equipment was started. In the effort on chemonuclear fuel development, a study of the gas dynamic properties of simple thin foils and honey-comb assemblies is being made. Various fabrication techniques are being studied. Capsule irradiations of N_2-O_2 mixtures with fission sources are being made for determining N_2O and NO_2 steady-state concentrations. In the basic radiation research effort, a model is proposed to account for the molecular weights of acrylamide observed at low concentrations of acrylamide in mixed crystals of propionamide. The propionamide-acrylamide system is under continuing study and some preliminary work was initiated on the solid-state polymerization of trioxane. The radiolysis studies on toluene were completed and G values are reported for the various radiolysis products. Styrene was polymerized in the liquid state at room temperature at rates which are 30 times faster than previously reported values. Electrolytic conductance measurements on Na salts of anthracene in tetrahydrofuran were made and the results are consistent with the theory of Debye and Falkenhagen who predicted a dispersion of conductance at high frequencies due to asymmetry or relaxation effects of the ionic atmosphere. (auth)

12140 (CONF-187-75) FEASIBILITY OF A LIQUID PHASE CHEMONUCLEAR OZONE PROCESS. J. P. Cagnetta, D. Goellner, and M. Steinberg (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract [AT(30-2)-Gen-16]. 7p.

A plant design for the production of ozone using fission fragments was established to study the feasibility of such production. The ozone production rate was estimated to be G = 15, a reactor with liquid oxygen as moderator and allowing boiling of the oxygen-ozone mixture was chosen, and the ozone production rate of the plant was set at 130 tons/day. Possible fuel shapes are described, and some of the core parameter study results are given. Various aspects of the chemical process system are discussed. The total plant investment cost is estimated to be ~$100 million, 90% of which is attributed to the nitrogen refrigeration system. This results in a production cost of ~50¢/lb for pure liquid ozone. The large capital investment of the refrigeration compressors will have to be reduced for lower ozone costs. (D.L.C.)

12141 (MITNE-39) THE EFFECTS OF REACTOR IRRADIATION ON SANTOWAX OMP AT 610°F AND 750°F. C. D. Sawyer and E. A. Mason (Massachusetts Inst. of Tech., Cambridge). Sept. 1963. Contract AT(10-1)-1067. 535p. (IDO-11107)

Santowax OMP has been irradiated in the M.I.T. In-Pile Loop Facility at 610°F and at 750°F. At both temperatures the loop was operated in a transient phase and a steady-state-HB phase. In the transient phase, unirradiated material was allowed to degrade to 60 wt % DP. In the steady-state-HB phase, the HB content of the coolant was maintained constant at about 33 wt % by the removal and distillation of samples and the replacement of the HB by unirradiated material before returning the samples to the loop. Neutron and gamma ray doses were measured with adiabatic calorimeters and foil monitors. The average dose rate to the coolant in the core region of the in-pile section was about 0.5 watts/gm, of which 37% was due to fast neutron interactions and 63% to gamma ray interactions. Terphenyl concentrations were measured by gas chromatography and HB concentrations by distillation. Analysis of the transient phase terphenyl concentration and absorbed dose data showed that first order kinetics provided an adequate description of the degradation rate of the terphenyls. At 610°F no significant difference in the stabilities of the terphenyl isomers was found and the overall degradation rate of the coolant was $G^*(-omp) = G(-omp)/C_{omp} = 0.26 \pm 0.01$ molecules of terphenyl degraded per 100 ev absorbed in the terphenyls. At 750°F the terphenyl isomer stabilities were in the order para > meta > ortho. After corrections for out-of-pile pyrolysis, the over-all degradation rate of the coolant was $G^*(-omp) = 0.49 \pm 0.02$. The results are compared to those of other investigations. For the 610°F irradiation the radiolytic gas generation rate was G(total gas) = 0.037 ± 0.003 molecules of gas produced per 100 ev absorbed in the coolant mixture, the principal product being hydrogen. During the 750°F irradiation the generation rate was G(total gas) = 0.105 ± 0.008, with a marked increase in the evolution of methane. Physical property measurements included

density, viscosity, specific heat, thermal conductivity, number average molecular weight, gas solubility, carbon-hydrogen content, and ash content. The increase in viscosity with increasing DP concentration was significantly less for the 750°F irradiation than for the 610°F irradiation. Heat transfer measurements showed that standard correlations could be used to determine the heat transfer rates using the physical properties of the irradiated coolant. The correlation obtained for the data of both irradiations was $Nu = 0.0079(Re)^{0.9}(Pr)^{0.4} \pm 10\%$. No evidence of scale buildup on the heat transfer surfaces was observed over the entire period of operation of the experiment. The results of preliminary measurements with a fouling probe are also reported. (auth)

12142 (NYO-7988) RADIATION CHEMISTRY PROGRESS REPORT, APRIL 1, 1963–MARCH 31, 1964. Gilbert J. Mains (Carnegie Inst. of Tech., Pittsburgh). Jan. 4, 1964. Contract AT(30-1)-2007. 46p.

The Hg^6 ($^3P_1$) photosensitized decomposition of SiH_4 and a 1:1 SiH_4–SiD_4 mixture was studied at 1 cm pressure and 25°C. Quantum yields of hydrogen and disilane were estimated to be 1.8 and 0.6 respectively, at low conversion. Polymeric silicon hydride was deposited on the walls as the reaction proceeded toward a photostationary state. The uniformity of the polymeric film was taken as evidence that the "zebra" effect is not important in this system. The failure of large concentrations of ethylene to reduce the yield or isotopic distribution of hydrogens from the decomposition of the SiH_4–SiD_4 mixture indicated that the reaction between atomic hydrogen and monosilane is very rapid. As previously reported, trace amounts of xenon inhibits the H_2–D_2 exchange induced by radiation with 3-Mev electrons and 3-Mev x rays at 25°C. However, in the 50 kvp x-ray radiolysis at 25°C, the yield of HD was found to increase significantly at a concentration of xenon exceeding 2%. The yield of HD was similarly found to increase in all types of radiation at 262°C. This increase in the HD yield under these conditions was taken as evidence that xenon sensitizes the atomic exchange reaction more efficiently than it inhibits the ionic chain exchange reactions. Xenon sensitization of the H_2–D_2 exchange was demonstrated by the production of significant yields of HD in the 1470 Å vacuum ultraviolet photolysis of an equimolar mixture of H_2 and D_2 in the presence of xenon. The increase of the atomic exchange reaction by mercury photosensitization was also demonstrated in the 50 kvp x-ray radiolysis at 262°C. The inapplicability of microscopic reversibility in the mercury photosensitized exchange H_2–D_2 was experimentally confirmed by the deviation of the photostationary state constant from the equilibrium constant. Moreover, the photostationary state constant reached a maximum at about 2-cm-Hg pressure and sharply decreased on both sides of this pressure. The photostationary state constant was largest for an equimolar mixture over the entire range of pressures. Inert gases did not change the rate of HD formation nor the photostationary state constant over the entire pressure range. In one series of experiments, a diffusion-free quartz disc was placed in an end-on-window type reaction vessel. The decrease in the rate of HD formation was observed at various disc positions within about 2 cm from the window. The variation of HD formation as a function of the disc distance indicated that the effective reaction zone was determined by the diffusion of H and D atoms. Pressure effects on the initial rate of HD formation suggested that wall recombination is predominant at low pressures, while homogeneous exchange increases linearly with total pressure. The initial rate of D_2 formation from HD decomposition was also studied and was found to be essentially due to the homogeneous reaction at high pressures. The variation of the photostationary state constant with pressure can be qualitatively explained in terms of the pressure effects on the forward and backward rates. (auth)

12143 (PAN-456/XVII) WŁASNOSCI I ZASTOSOWANIE REGENERATU OTRZYMYWANEGO Z γ-NAPROMIENIANYCH ZUZYTYCH OPON SAMOCHODOWYCH. (Properties and Application of Reclaimed Rubber Produced from Irradiated Old Motor Tires). Wacław Zelinski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Apr. 1963. 12p.

A method is suggested for reclaiming used, irradiated rubber tires. Mechanical properties of sulfuric rubber vulcanizer and its resistance to swelling in oils are investigated. (tr-auth)

12144 (PAN-457/XVII) EFFECT OF INORGANIC ADDITIVES ON THE RADIATION-INDUCED VULCANIZATION. [PART] II. Waclaw Zielinski, Zygmunt Smigasiewicz, and Janina Zurakowska-Orszagh (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). May 1963. 13p.

Investigations on the effect of heavy metal oxides and halides on the process of radiation vulcanization of natural rubber were carried out. The degree of crosslinking by measurement of equilibrium compression modulus and equilibrium volume swell were studied. (auth)

12145 (PRNC-14) RESONANCE IN RADIATION EFFECTS. Progress Summary Report No. 1, March 1963. Henry J. Gomberg (Puerto Rico Nuclear Center, [Mayagüez]). Contract AT(40-1)-1833. 12p. (CONF-252-4)

From 2nd Caribbean Chemical Symposium, Rico Piedras, P. R., Aug. 1963.

Dilute solutions of the iron metalloenzyme catalase were irradiated with monochromatic x rays of energy 6 to 9 kev ± 50 ev. A ferrous-ferric micro-dosimetry technique was developed. The results show an increased inactivation of the iron enzyme at or near the K-absorption edge of iron (7.11 kev), in agreement with theory and experiment. The characterization of a high-intensity monochromatic x-ray source in the 5 to 20 kev region is described. (D.L.C.)

12146 (RAI-314) RADIATION-INDUCED SOLID PROPELLANT DECOMPOSITION. George Odian, Terese Acker, and Thomas Pletzke (Radiation Applications Inc., Long Island City, N. Y.). Jan. 15, 1963. Contract AF49 (638)-1125. 21p.

A research program is being conducted to study the mechanism of solid propellant combustion. The decomposition products of gamma-irradiated ammonium perchlorate were determined. A study of the reactions of ammonium perchlorate with organic compounds showed that ammonium perchlorate is an oxidizing agent only at temperatures above its decomposition point. The effects of electron irradiation on the burning rates and tensile strength of composite ammonium perchlorate solid propellants were determined. (D.L.C.)

12147 (RRL-127) QUARTERLY REPORT [ON RADIATION RESEARCH], OCTOBER 1, 1963–DECEMBER 31, 1963. Fundamental Research No. 6041. (Mellon Inst. Radiation Research Labs., Pittsburgh). Jan. 8, 1964. Contract AT(30-1)-2310. 11p. (NYO-10483)

Research activities of the Mellon Institute Radiation Research Laboratories are summarized. Abstracts are included for six papers issued in the field of radiation chem-

istry and summaries are presented on eight programs under investigation. Special interest is shown for the radiolysis of cyclohexene and oxygen-saturated methanol-sodium nitrate solutions. (N.W.R.)

12148 (TID-20067) EFFECTS OF HIGH ENERGY IONIZING RADIATION ON COLLOIDAL SYSTEMS AND SUSPENSIONS. Final Report, March 1, 1962 to October 31, 1963. W. H. Burrows, W. J. Corbett, P. E. Gaffney, and Clyde Orr, Jr. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Dec. 18, 1963. Contract AT(38-1)-202. 94p.

The effects of x and gamma radiation on several solid-liquid colloidal systems was investigated in an attempt to partially or completely neutralize the surface charges on the particles. This might, it was thought, reduce the repulsive, stabilizing forces on the particles in suspension and effect their coagulation and precipitation. With stannic oxide, bacterial, and natural river water suspensions, both types of irradiation resulted in partial charge reduction as measured by microelectrophoretic immigration. Neither resulted in precipitation, however. Ferric and aluminum oxide sols were not amenable to microelectrophoretic mobility measurement, so the effect of radiation on their surface charge could not be determined. Irradiation, nevertheless, was not effective in precipitating these suspensions. Coagulation of bacterial (Escherichia coli) suspension was found only with a combination of low pH and high radiation dose. The effects of ionizing radiation on aerosols of both solid particles and liquid droplets were examined using argon, carbon dioxide, helium, nitrogen, and oxygen-nitrogen mixtures as the carrier gases. The source of radiation in these studies was an x-ray machine operated at 60 kvp and 5.5 ma. The only detectable effect of exposure of aerosols to the ionizing radiation was a neutralization of the electrostatic charge they had acquired as a consequence of generation. The principal mechanism of neutralization appeared to be a capture of gas ions and thermal electrons. Exposure of the aerosols to ionizing radiation produced no detectable effect on the degree of coagulation of the aerosol particles. Efforts to measure the effect of exposure to ionizing radiation on the filterability of the aerosols were unsuccessful. The principal effort on emulsions and foams centered about the development of suitable techniques for studying the effects of ionizing radiation on them. Special chambers for both x-ray and ultraviolet irradiations were designed and constructed, and a special microelectrophoresis cell was fabricated. Closed circuit television microscopy was employed. Emulsions were produced with from very low to zero surfactant concentrations in order to reduce effects unrelated to radiation. Also, the use of isopycnic emulsions prepared from liquids of similar viscosities permitted new degrees of freedom to be achieved. Settling was reduced to a minimum, and phase reversal was readily accomplished with the resulting emulsions. Means were provided for conducting studies on emulsion pairs representing two systems, each of which is the reversed phase counterpart of the other. Preliminary observations indicated considerable potential in these techniques for fundamental work. (auth)

12149 (TID-20072) PHYSICAL PROPERTIES AND STRUCTURAL CHARACTERISTICS OF POLYMERS RESULTING FROM "POST-EFFECT" POLYMERIZATION. Final Report, March 1, 1962–October 31, 1963. L. W. Elston and W. H. Burrows (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Nov. 22, 1963. Contract AT(38-1)-202. 52p.

Post-effect polymerization is being used to examine the mechanisms and kinetics of vinyl polymerization. The extent of polymerization and viscosity and the average molecular weight as functions of initiating dose and post-effect time at room temperature were observed. Methyl methacrylate was the monomer used in all experiments. Radiation doses up to 8.73×10^5 rads and post-effect times up to 194 hours were employed. A low-temperature method for quenching and transfer of viscous samples were developed. (auth)

12150 (TID-20124) [PHOTORESPONSIVE SYSTEMS. II]. [Period Covered]: July 1, 1963–January 27, 1964. [Rex Lovrien and Jean C. B. Waddington] (Minnesota. Univ., Minneapolis). Contract AT(11-1)-341. 9p.

Water-photochromic azo dyes with vinylamide groups were synthesized and copolymerized with acrylic or methacrylic acid to yield photochromic polyelectrolytes. The optical behavior of the isomerizing side chains was qualitatively studied spectrophotometrically. A preliminary comparison with adsorption-bound dyes was made. Results showed that –N=N– cis-trans geometry of the various dyes can be switched at will by irradiation, but the relaxation processes vary with environment of the dye, so that three distinct types of dye are defined: free dyes, adsorption-bound dyes, and covalently bound (or tethered) dyes. All these behave reversibly, and relaxation is accelerated by nucleophilic reagents. In the case of the tethered dyes, irradiation response and dark relaxation behavior are linked to the charge and conformation of the copolyelectrolyte. (auth)

12151 (TID-20192) CHEMICAL EFFECTS OF THE NUCLEAR REACTION $N^{14}(n,p)C^{14}$ IN VARIOUS IRRADIATED NITROGENEOUS COMPOUNDS. John D. Vaughan (Hawaii. Univ., Honolulu). [1962]. 26p.

An investigation is being made of the hot-atom chemistry of carbon-14 in liquid hydrazine and in hydrazinium salts. After irradiation, the target is dissolved, carrier compounds added and separated, and the activities of the separated carrier fractions determined. Preliminary results are reported for hydrazine sulfate and hydrazine dihydrochloride. The chemical processes and possible mechanisms are discussed at some length. (D.L.C.)

12152 (TRECOM-TR-62-90) BASIC STUDIES ON RADIATION ENERGY TRANSFER MECHANISMS OF CHEMICAL SYSTEMS. George E. Bohner (Denver. Univ. Denver Research Inst.). Dec. 1962. Contract DA44-177-TC-725. 95p. (AD-401113)

Some organic compounds are able to protect others from degradation while under the influence of high-energy irradiation. Cyclohexane was chosen as the solvent to be studied, with benzene, biphenyl, and naphthalene being the principal protecting additives. By identifying the various products formed in these solutions and determining the influence of dose and additive concentration on the rate of formation of the products, certain conclusions regarding the radiolytic degradation mechanisms can be made. The formation and subsequent reactions of radiolytically formed free radicals cause most of the degradation observed in pure cyclohexane. When an aromatic additive is present, it reacts with these radicals and competes with the normal degradation reactions. Experimental results can be explained in terms of free radical mechanisms. A reaction degradation scheme is proposed which is consistent with the experimental results. (auth)

12153 (USNRDL-TR-699) GAMMA RADIATION EFFECTS ON ISOPRENOIDS. III. 2-METHYLBUTENE-2

AND 2-METHYLBUTANE. W. E. Shelberg and J. F. Pestaner (Naval Radiological Defense Lab., San Francisco). Oct. 28, 1963. 13p. (AD-428441)

Hydrogen and methane radiation yields (molecules per 100 ev absorbed) were determined for 2-methylbutene-2 and 2-methylbutane. $G(H_2)$ and $G(CH_4)$ are 1.15 and 0.20 respectively for 2-methylbutene-2, and 4.60 and 0.57 respectively for 2-methylbutane. The hydrogen and methane yields are linear with dose at low conversions. The value of $G(H_2)$ for 2-methylbutene-2 fits a relationship (previously reported) which defines $G(H_2)$ for rubber-type isoprenoids (such as 2,6-dimethyl-octadiene-2,6, squalene, and rubber) in terms of the number of their isoprenoid units, so that $G(H_2) = 0.48\ (1 + 1.4/I)$, where I is the number of isoprenoid units. (auth)

12154 APPLICATION OF THE MIXED CRYSTAL METHOD FOR THE PREPARATION OF CARRIER-FREE RADIOACTIVE ISOTOPES. I. B. Toth (Izotop Intezete, Orszagos Atomenergia Bizottsag, Budapest). Acta Chim. Acad. Sci. Hung., 29: 447-62(1961). (In Russian)

The effect of the capillary layer between the solid and liquid phases of heterogeneous systems on the formation of mixed crystals was investigated. The distribution of Ba^{140} between a previously prepared solid phase of $PbSO_4$ and a saturated aqueous $PbSO_4$ solution was studied by the isotherm method. The Doerner-Hoskins constant (λ) was found to be 2.58 at 0, 5.56 at 25, and 6.09 at 40°C. The value of the same constant by a fractional precipitation technique was found to be 7.53. The same experiments were also carried out with Sr^{90} and $PbSO_4$. By the isotherm method, λ was found to be 0.346 at 0, 0.276 at 25, and 0.269 at 40°C; by fractional precipitation, 0.082 at 25°C. The results agree within experimental error. The distributions quotients indicate that Ba is enriched in the solid phase, but that Sr is not. Capillary layers are thus involved in the mechanism of solid solution formation and also in determination of the terminal equilibrium state of solid solutions. (BBB)

12155 ADVANCES IN INORGANIC CHEMISTRY AND RADIOCHEMISTRY. VOLUME 5. H. J. Emeléus and A. G. Sharpe, eds. Advan. Inorg. Chem. Radiochem., 5: 1-429(1963). New York, Academic Press Inc., 1963.

Advances in inorganic and radiochemistry are reported in eight papers. Separate abstracts were prepared for papers on stabilization of oxidation states of transition metals and chemical effects of nuclear activation in gases and liquids. Other topics covered include: oxides and oxyfluorides of the halogens, chemistry of gallium, gaseous hydroxides, borazines, decaborane-14 and its derivatives, and structure and reactivity of organophosphorus compounds. (M.C.G.)

For abstracts of individual papers see: 12046 and 12156.

12156 CHEMICAL EFFECTS OF NUCLEAR ACTIVATION IN GASES AND LIQUIDS. I. G. Campbell (Univ. of Manchester, Eng.). Advan. Inorg. Chem. Radiochem., 5: 135-214(1963).

Chemical effects of radioactivation are reviewed. Topics covered include: origin of chemically significant energy from nuclear processes, loss of energy by atoms activated in nuclear processes, bond activation by recoil, bond rupture in the (n,γ) reaction, bond rupture by charging processes, bond rupture in isomeric transition, bond rupture in beta decay, hot reactions resulting from nuclear activation, thermal or diffusion-dependent reactions after nuclear activation and radiation effects. (343 references). (M.C.G.)

12157 PREPARATION OF CARRIER-FREE THORIUM-234 TRACER. Claude W. Sill (Atomic Energy Commission, Idaho Falls, Idaho). Anal. Chem., 36: 675-6(Mar. 1964).

A procedure is described for the preparation of carrier-free Th^{234} to be used in solutions containing high concentrations of calcium such as bone ash. The solutions can also be standardized by gamma counting after determining the counting efficiency for a given set of conditions. (P.C.H.)

12158 MECHANICAL RELAXATION AND MOLECULAR MOBILITY PHENOMENA IN IRRADIATED ISOTACTIC POLYPROPYLENE. Enzo Butta and Vittorio Frosini (Università, Pisa, Italy). Ann. Chim. (Rome), 53: 1025-33 (July 1963). (In Italian)

Cylindrical samples of isotactic polypropylene were irradiated in the reactor of the Società Sorin at Saluggia (mixed irradiation: fast and slow neutrons and gamma rays); the dose varied from 0 to 2200 Mrad. The density of the irradiated samples decreased from 0.914 g/cm^3 above 270 Mrad and passed through a min (0.889 g/cm^3) at 1320 Mrad. The velocity of sound (1 mm Hg) decreased from 2200 m/sec to 1300 m/sec at 1320 Mrad, then rose; likewise Young's modulus decreased from 4.47×10^{-10} d/cm^2 to 1.50×10^{-10} d/cm^2 (min) at 1320 Mrad. Velocity of sound and coefficient of internal dissipation were plotted with respect to temperature from −180°C to 160°C for each sample. In low-dose samples (to 269 Mrad) the velocity of sound decreases linearly with increasing temperature to a point T_g (−40°C to 0°C) when the slope becomes steeper. Another singular point near −130°C is noted for higher-dose samples. In low-dose samples internal dissipation increases slowly to −20°C, then increases rapidly and passes through a maximum at 40°C. In medium-dose samples (360 Mrad, 864 Mrad) the internal dissipation curve shows secondary relaxation phenomena at low temperatures and has a double max between 40°C and 80°C. In high-dose samples (1320 to 2200 Mrad) there is one max; at high temperatures the 2200 Mrad sample behaves like vulcanized rubber. These results are interpreted in terms of the destruction of crystallinity in the samples: intermediate-dosage samples have increasing numbers of tranverse bonds formed by irradiation; high-dose samples have no remaining crystallinity. The results are in accord with published data for polyethylene. (BBB)

12159 THE MÖSSBAUER EFFECT AND ITS APPLICATIONS IN CHEMISTRY. V. I. Goldanskii (Inst. of Chemical Physics, Moscow). At. Energy Rev., 1: No. 4, 3-70(1963).

General characteristics of the Mössbauer effect, isomeric (chemical) shifts, and quadrupole splitting of Mössbauer spectral lines are described. Characteristics of the Mössbauer effect that are important in conjunction with its application to problems of molecular structure—such as the prevalence of Mössbauer nuclei, the role of a light-atom environment, short-range and long-range effects and relaxation times—are also discussed. The most important chemical aspects of the first Mössbauer experiments in iron are considered: studies dealing with local magnetic fields in Fe^{2+} and Fe^{3+}, the contribution of s electrons to the valence bonds of iron atoms, compounds in which iron performs a double function, the chemical states of iron after beta-decay of cobalt, and a study of ferrocene and its derivatives. Similarly, the survey deals with the basic chemical aspects of the first Mössbauer experiments in tin. This includes the problem of covalent and ionic bonds in Sn^{2+} and Sn^{4+}, the role of co-ordination bonds, the role of electronegativity in atoms near tin, the structural differences between stannic tetrafluoride and

other tetrahalides and inductive and mesomeric effects in Mössbauer spectra. The nature of line splitting is discussed, as is the possibility of studying the properties of monocrystals in polycrystalline samples. Mössbauer spectra of organo-tin compounds and their structural properties, as well as the Mössbauer effect in tin-bearing polymers are considered. In conclusion, a few questions of general interest are considered, including the prospects of using the Mössbauer effect in chemistry. The influence of the nearest as well as the more remote intramolecular bonds are discussed: collective interaction in polymers (in conjunction with the kinetics of solid-phase polymerization and the role of phase transitions); the structure of complex compounds; the possibility of studying the kinetics of topochemical and liquid-phase reactions; radiation-damage studies, including the problems of annealing and retention; the possibility of making analytical measurements; and finally, the possibility of observing resonance scattering and absorption in connection with macromolecular recoil. 137 references are included. (P.C.H.)

12160 THE ACTIVATION OF CATALYSIS BY NEUTRON BOMBARDMENT. Vikt. I. Spitsyn, I. E. Mikhailenko, and G. N. Pirogova. At. Energ. (USSR), 15: 520-2 (Dec. 1963). (In Russian)

A study was undertaken on the catalytic dehydration of pure n-decyl and n-duodecyl alcohols and the isomerization of the products by irradiated Al_2O_3 and its phosphated compound. The catalysts which had a grain size ranging from 1 to 2 mm, were exposed to slow neutrons and γ rays in the reactor at a flux of about 0.8×10^{13} n/cm^2 sec; this caused the formation of radioactive isotopes of the main components and the impurities, including Fe^{59}, Na^{24}, and Cu^{64}; the Al and O yielded only the short-lived Al^{28} and O^{19}; the phosphate sample contained also P^{32}. The dehydration studies indicated that the catalytic activity of the unirradiated and irradiated Al_2O_3 differed only slightly; the isomerization of the olefinic reaction products was enhanced by the irradiated material. The specific surface of the oxide was not changed by the irradiation. Irradiation of the phosphated material for 2 days resulted in the reduction of its catalytic activity but exposure for 1 month caused an increase. It was surmised that the β activity of P^{32} overcame the negative effect of the neutron bombardment. It is considered possible that under the effect of the irradiation the number of active centers in the catalyst decreases, resulting in a smoothing out of the surface. (TTT)

12161 THERMAL AND RADIATION OXIDATIONS OF BENZENE TO PHENOL IN AQUEOUS SOLUTIONS CONTAINING METAL IONS AT ELEVATED TEMPERATURES. III. THE EFFECT OF COPPER IONS. Hiroshi Hotta, Nobutake Suzuki, and Akira Terakawa (Japan Atomic Energy Research Inst., Tokyo). Bull. Chem. Soc. Japan, 36: 1255-8(Oct. 1963).

Results of the oxidation of benzene to phenol in cupric aqueous solutions are discussed. The yield of phenol increases abruptly above 170°C in cupric sulfate solutions. When the solutions contain copper metal pieces, phenol is produced, even below 160°C, regardless of irradiation or non-irradiation. On the other hand, scarcely any phenol is produced in the cupric-ferric sulfate solution, even at 180°C. The results are attributed to the fast rate of cuprous oxidation by oxygen. (P.C.H.)

12162 HIGH-KINETIC ENERGY FRAGMENT IONS FROM ALIPHATIC HYDROCARBONS UNDER ELECTRON IMPACT. III. NINE HYDROCARBONS RANGING FROM C_2 TO C_4. Toshikazu Tsuchiya (Government Chemical Industrial Research Inst., Tokyo). Bull. Chem. Soc. Japan, 36: 1290-4(Oct. 1963).

Fragment ions produced by electron impact with excess kinetic energies from into nine hydrocarbons ranging from C_2 to C_4 were investigated. Fragment ions of a higher mass number could not be measured. To explain the decomposition of molecules other than propylene, reactions producing ions with excess kinetic energy as well as neutral fragments must also be taken into consideration. (auth)

12163 RADIATION GRAFTING OF VINYL ON CELLULOSE. Can. Chem. Process., 46: 57-8(Nov. 1962).

Styrene, methyl methacrylate, and other vinyl-type monomers were grafted to tire-cord rayon by radiation. The cellulose is swelled with water and alcohol is used to improve chemical bonding. (P.C.H.)

12164 NEW ORGANICS PROBE RADIATION DENSITY. Can. Chem. Process., 46: 61; 63(Nov. 1962).

The development and properties of liquid and plastic phosphors are discussed. The advantages of organic phosphors over inorganic ones are mentioned. (P.C.H.)

12165 ON THE EQUILIBRIUM ATTAINED BY ELECTROLYTIC SOLUTIONS UNDER IONIZING RADIATION. J. R. Coleman (Defence Research Chemical Labs., Ottawa). Can. J. Chem., 42: 477-80(Feb. 1964).

The effects of gamma and x irradiation on redox systems in aqueous solution and the resulting potentials were studied for nitrite–nitrate, iron and cerium sulfates, H_2SO_4 alone, and iodide–iodine solutions. Each system is discussed separately. In all the systems studied except iodine, the final potentials reached after prolonged irradiation can be reproduced simply by adding H_2O_2 to the original solution. Also, in the presence of a redox couple that is electromotively active on platinum, the potential observed during oxidation or reduction of the couple by irradiation is that of the couple itself. That is, all values are ascribable to molecular products of irradiation. (P.C.H.)

12166 ENRICHMENT OF CHROMIUM-51 BY SZILARD-CHALMERS PROCESS. Chung-hsiung Tsai and Si Jung Yeh (National Tsing Hua Univ., Taiwan, China). Chem. Soc. (Taiwan), 10: 16-23(Mar. 1963).

Attempts were made to examine the feasibility of using an ion-exchange method to separate the Cr from chromate targets. An anion-exchange resin was selected, rather than cation exchange because elution of Cr from the cation resin is difficult and the efficiency of Cr recovery lower. Successful enrichment of Cr^{51} was achieved with a potassium chromate target, (enrichment factor ~3000), and comparison was also made with an ammonium chromate target. Neutron bombardment of potassium chromate and ammonium chromate was carried out in the presence of air. Separation of Cr^{51} from the target material was carried out by Dowex 2 × 8 (50-100 mesh) cycled in chloride form. A 0.9 × 9-cm column was used to treat about 30 mg of irradiated chromate. A study of the reduction of chromate by anion exchanger Dowex 2 at different contact times and at a fixed acidity showed that the reduction is almost completely depressed if the contact time between the exchanger and chromate is less than 1 min (for both potassium chromate and ammonium chromate). At a fixed contact time, reduction of chromate becomes appreciable, though not serious when the acidity exceeded 0.1N HCl. Thus, rapid separation from target material must be carried out to minimize the reduction of chromate by anion-exchange resin, so that the optimum enrichment of Cr^{51} can be effected. By use of potassium chromate as target, an enrich-

ment factor as high as 3000 was obtained under favorable conditions. When ammonium chromate was used as the target material, rather lower enrichment factors were obtained despite the fact that much higher over-all radioactivity recovery was observed. (TCO)

12167 APPARATUS FOR EVAPORATING SMALL, RADIOACTIVE SAMPLES. J. H. Copenhaver and A. M. Gawienowski (Kansas State Univ., Manhattan). Chemist-Analyst, 53: 23(Jan. 1964).

An apparatus is described for effectively concentrating small volumes of dilute solutions, especially radioactive ones. The apparatus can be assembled from a commercial flash evaporator and an intermediate glass connector attached to a scintillation bottle by Parafilm. (P.C.H.)

12168 RADIOCHEMICAL COPOLYMERIZATION IN THE SOLID PHASE. Adolphe Chapiro, Anna-Maria Jendrychowska-Bonamour, and Daniel Roussel (CNRS. Bellevue, France). Compt. Rend., 258: 914-17(Jan. 20, 1964). (In French)

The copolymerization of styrene with methyl methacrylate and acrylonitrile were studied at −78° in a rigid medium using gamma radiation to enhance the reaction. The kinetics of the reactions as well as the composition of the copolymers indicates that the copolymerizations proceed by a radical mechanism, the reaction of termination being strongly retarded. (tr-auth)

12169 AN ELECTRON MICROSCOPIC STUDY OF GRAFT POLYMERS. E. M. Belavtseva, K. Z. Gumargalieva, and A. I. Kitaigorodskii (Inst. of Organometallic Compounds, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 153: 631-3(Nov. 21, 1963). (In Russian)

Samples of polyethylene, polypropylene, and polycaprolactam resin were grafted with polyacrylic acid by a gas-phase irradiation and polymerization, as described by Vlasov in Dokl. Akad. Nauk, 144: 382(1962). The content of grafted material was 56.5% for polyethylene, 31% for the polycaprolactam resin, and 1.8% for the polypropylene. In order to determine the distribution of graft polymer within the synthetic polymer, the graft polymer was boiled for three hours in a solution saturated with silver sulfate. The hydrogen ion of the carboxylic group of acrylic acid was partially replaced by silver ions by this treatment. The replacement of hydrogen ions by silver ions was 23.6% for polyethylene, 16.6% for the polycaprolactam resin, and <0.5% for the polypropylene. Electron microphotographs of the graft polymers infiltrated with Ag_2SO_4 showed a correlation between the contrast of the photograph and the amount of grafted material. The position of the grafted acrylic acid could be determined by the high contrast of the silver particles on the photograph. No difference in contrast was observed, if the treatment with Ag_2SO_4 were omitted. The density distribution of grafted material decreased with increasing depth of polymer. (TTT)

12170 DEPENDENCE OF THE YIELD OF MOLECULAR PRODUCTS OF THE RADIOLYSIS OF WATER ON THE RADICAL ACCEPTOR CONCENTRATION. V. M. Byakov (Inst. for Theoretical and Experimental Physics, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 153: 1356-9(Dec. 21, 1963). (In Russian)

It was found experimentally for many systems that, in an irradiated solution (for example, by hard gamma rays of Co^{60}), as the concentration of the radical acceptors H and OH increases, the yield of H_2 and H_2O_2 molecules decreases linearly with the cube root of the acceptor concentration. Attempts to derive the cube-root equation were not successful, but an approximate method is presented. It is considered valid for the following conditions: the number of radicals captured by an acceptor in a short time is small compared to the number recombining in that same interval of time; and the number of radicals recombining in a long time is small compared to the number captured by an acceptor in this same interval of time. This was found to hold true for the case of an acceptor concentration much less than 1 mole/l. Calculations were made by means of the derived equation and were found to be in good agreement with data found in experimental work. (TTT)

12171 EFFECT OF SEMICONDUCTOR ADDITIVES ON RADIATION POLYMERIZATION OF ACRYLONITRILE AND METHYLMETHACRYLATE. L. P. Mezhirova, A. P. Sheinker, and A. D. Abkin (Karpov Inst. of Physics and Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 153: 1378-80(Dec. 21, 1963). (In Russian)

The rate of acrylonitrile (m.p. −81.7°C) polymerization by gamma irradiation at −78°C was not increased by increasing the reaction surface area with the addition of glass powder, but was actually decreased 2-fold by a 20-fold area increase. The rate also was not increased by the addition of ZnO, TiO_2, or Cr_2O_3 (n-type semiconductors) but was sharply increased by addition of Cu_2O, Ni_2O, and $Li_2O + Ni_2O$ (p-type semiconductors) and MgO. The molecular weight of the polymer also increased. The rate increased also in the presence of triethylamine when p-type conductors were added. At 0°C the accelerated effect was not observed, and it was only slight in the presence of triethylamine. The rate of acrylonitrile polymerization in the solid state, at −196°C, in the presence of Cu_2O and MgO was more than twice that in the absence of additives. The radiation polymerization process at 0°C and higher is considered to be a radical mechanism, but the results indicated that at low temperatures the mechanism may be anionic. Infrared absorption in the polymer obtained in the presence of oxide additives was found at 1675 cm^{-1}, indicating that polymerization occurred not only on the $=C=C$ bond but also on the $-C\equiv N$. A significant kinetic effect was also shown in polymerization of methylmethacrylate (m.p. −52.5°C) in the presence of MgO at low temperatures. This polymethacrylate obtained at −56°C had a high density. (TTT)

12172 PREPARATION AND DECOMPOSITION OF SOME DIOLEFINS LABELED WITH C^{14}. Gastone Pajaro and Alberto Valvassori (Università, Naples). Gazz. Chim. Ital., 92: 1446-51(Dec. 1962). (In Italian)

Four diolefins marked at specific positions were synthesized to determine the composition of copolymers containing one of the diolefins as comonomer. Vinyl = magnesium chloride was carbonated with labeled CO_2 in tetrahydrofuran at −10°C and the acrylic acid thus obtained was reduced to allyl alcohol with $LiAlH_4$ in ether. The alcohol was converted to allyl bromide-1,3-C_2^{14} with PBr_3. The Grignard reagent prepared from this was added to methallyl chloride, giving 2-methyl-1,5-hexadiene-4,6-C_2^{14}. Oxidation with $KMnO_4$ produced CO_2 with ~3.5 times the activity of CO_2 formed by complete oxidation of the diolefin. Ethylene-C_2^{14} absorbed Br_2 to give the dibromoethylene, which yielded labeled vinyl bromide on treatment with aqueous-alcoholic (1:1) KOH. The corresponding Grignard reagent, prepared in tetrahydrofuran, was added to methallyl chloride. The product of the reaction, complete after 2-hr reflux, was 2-methyl-1,4-pentadiene-4,5-C_2^{14}, whose oxidation at pH 4 with $KMnO_4$ produced CO_2 with ~1.5 times the activity of CO_2 produced by total oxidation. Labeled KCN and 1,3-dibromopropane gave the dinitrile in refluxing methanol-water (3:10). After removal of

CH_3OH, H_2SO_4 was added; refluxing 15 hr gave labeled glutaric acid, which was reduced to pentane-1,5-diol with $LiAlH_4$ in ether. Acetic anhydride was added at 150°C and the mixture refluxed for 3 hr, giving the diacetate, which was pyrolyzed in a quartz tube at 575°C to yield 1,4-pentadiene-1,5-C_2^{14} all of whose activity was shown to be in the terminal carbons by complete and partial ($KMnO_4$) oxidation. Ethylmagnesium iodide-1,2-C_2^{14} was reacted by slow addition of freshly distilled acrolein. The alcohol obtained was treated with PBr_3, yielding the bromide, which was converted to a quaternary ammonium hydroxide and pyrolyzed in a known process. The 1,3-pentadiene-4,5-C_2^{14} formed was 73% trans (IR analysis); equilibration by refluxing with I_2 gave 85% trans, 15% cis diolefin. (BBB)

12173 PREPARATION AND DECOMPOSITION OF CYCLIC OLIGOMERS OF 1,3-BUTADIENE-C^{14}. Gastone Pajaro, Diego Fiumani, and Mario Moro (Università, Naples). Gazz. Chim. Ital., 92: 1452-8(Dec. 1962). (In Italian)

Acetylene-C^{14} was diluted with N_2 and passed through an aqueous formaldehyde suspension of 1:4 Bi_2O_3:CuO on silica gel in the presence of $CaCO_3$ at 95°C, giving labeled 1,4-butynediol. This was reduced with Raney Ni in methanol in an autoclave at 250°C to give the butanediol, which was converted by published methods into 1,4-dibromobutane and then to 1,3-butadiene-2,3-C_2^{14}. Labeled CH_3OH (from CO_2 and $LiAlH_4$) was converted to CH_3I with red P and I_2. The Grignard reagent prepared from this was added to acrolein, giving labeled 3-buten-2-ol. Passing the alcohol over Al_2O_3 at 350°C gave 1,3-butadiene-1,4-C_2^{14}. The 1,3-butadiene-2,3-C_2^{14} was converted to cis,cis-1,5-cyclooctadiene-1,2,5,6-C_4^{14} (after dilution with unlabeled butadiene) with bis(triphenylphosphito)nickel dicarbonyl catalyst in benzene in an autoclave at 100°C, and fractionally distilling the products. Heating 1,3-butadiene-1,4-C_2^{14} under 50 atm N_2 at 130°C for 30 hr in the presence of a little hydroquinone gave 4-vinyl-1-cyclohexene-3,5,6,8-C_4^{14} after fractional distillation. Use of a Ziegler-type catalyst ($Al(C_2H_5)_3$ and CrO_2Cl_2) on 1,3-butadiene-1,4-C_2^{14} in benzene at 50°C gives a mixture of trans, trans,trans- and trans, trans,cis-1,5,9-cyclododecatriene-3,4,7,8,11,12-C_6^{14}. The trans,trans,trans isomer was separated from the mixture by crystallization at 0°C, m.p. 34°C. The cyclic olefins were ozonized in $CHCl_3$ and the ozonides decomposed by H_2O_2 workup. The resulting acids were recrystallized to constant m.p. and then decarboxylated either with $Cu_2Cr_2O_4$ and quinoline or with Br_2 on Ag salts. The activity ratios of this CO_2 to that obtained for total combustion of the olefins agreed with the expected value in each case. (BBB)

12174 RADIOCHEMICAL SEPARATION OF La^{140} FROM Ba^{140}. Catello Cesarano and Giuseppe Pugnetti (Comitato Nazionale per l'Energia Nucleare, Casaccia, Italy). Gazz. Chim. Ital., 93: 28-37(Jan.-Feb. 1963). (In Italian)

An ion-exchange method for separating La^{140} from Ba^{140} was developed, so that carrier-free La^{140} may be obtained in a pure state (ratio of La^{140} disintegrations to Ba^{140} disintegrations, $>10^5$; chemical purity, $[La^{140}]/[Ba^{140}] > 1.3 \times 10^4$. The coefficient of distribution of the two elements on resin using 0.5% citric acid-ammonium citrate buffer of pH 5.5 was found to be 1.28×10^4. Dowex-50 resin in the ammonium form was found to retain Ba while the complex La citrate is eluted by the 0.5% solution. With a 8-mm dia column filled to a height of 15 cm, all the activity is collected in 50 ml of eluate with a slow flow rate (0.5 ml/min). The recovery yield of La^{140} is better than 95%; the first 3 elutions at 1-week intervals give 100% yields but afterwards the yield diminishes. The purity of La at the moment of separation is indicated by the ratio of activity, 2.5×10^{-6}. The amount of Ba in the eluate could be determined by separation with citrate buffer on an anionic column (Dowex 1 × 8). The recovery of Ba^{140} from a Ba–La carrier-free solution on such a column was 90–95%, decontamination factor $\sim 10^5$. (TCO)

12175 MINIMIZING SELF-ABSORPTION IN 4π β-COUNTING. N. A. Hallden and I. M. Fisenne (New York Operations Office, New York). Intern. J. Appl. Radiation Isotopes, 14: 529-32(Dec. 1963).

The incorporation of small Teflon particles into a solution of a weak β emitter, which is dried and 4π β-counted, was found to reduce self-absorption markedly. Sources of S^{35}, Pm^{147}, and Ni^{63} were studied with and without the Teflon treatment. In the case of S^{35}, self-absorption can be reduced from 28 to 5.1 per cent if the mass of the source is about 0.5 μg and 5 μg of Teflon particles are added. Promethium-147 self-absorption can be reduced from 17 to 2.4 per cent for carrier masses of <1 μg, and if as much as 10 μg of carrier is present Pm^{147} self-absorption can be reduced from 54 to 4.3 per cent. Nickel-63 self-absorption was reduced from 76 to 41.5 per cent but the original value of the Ni^{63} standard source was not known accurately. (auth)

12176 A METHOD OF PROCESSING DATA WHEN SEVERAL MIXTURES OF ELEMENTS ARE RESOLVED IN THEIR COMPONENTS. APPLICATIONS TO MIXTURES OF Fe^{59}, Na^{22}, Rb^{86}, and I^{131}. D. Yudilevich and P. Martin (Universidad, Chile, Santiago). Intern. J. Appl. Radiation Isotopes, 14: 563-70(Dec. 1963).

A method is presented that employs an inverse matrix to process data of experiments in which mixtures of radioactive isotopes are present and the individualization of the radioactivity of each isotope is desired. A specific example with a mixture of four tracers of biological interest (I^{131}, Rb^{86}, Na^{22}, and Fe^{59}) is given in detail. Sixty samples containing mixtures in different proportions were to be analized. The separation was performed by the combination of a detecting method, single-channel γ-spectrometry, and a mathematical method, the inverse matrix. Four energy levels are chosen for counting: 0.36, 1.10, 1.29, and above 1.40 Mev. Inversion of the matrix was carried out with a Friden SBT desk calculator. Analysis of error for the computed values is also described. The availability of digital computing has led to programming all computations. The method is generalized to combinations of various radiochemical procedures for separating isotopes. The requirements of the mathematical elements are also discussed. The applications of the matrix inversion to radioactivation analysis are discussed. The method also applies to non-radioactive mixtures. (auth)

12177 AUTO-RADIOLYSIS OF TRITIUM-LABELLED CYCLOHEXANE AND n-PROPANOL UNDER DIFFERENT CONDITIONS. J. G. Rabe, A. Guarino, and B. Rabe (Università, Rome). Intern. J. Appl. Radiation Isotopes, 14: 571-9(Dec. 1963).

Tritium-labeled cyclohexane, 2.952 mC/mg, and n-propanol, 2.272 mC/mg, were prepared and stored for a period of 90 and 120 days. Storing conditions were as follows: with air; in vacuum; in solution of benzene, and adsorbed on; cellulose; 1:2-benzanthracene; active charcoal; silica gel, and ferric oxides. The auto-radiolysis of cyclohexane in vacuum gave $G(H_2) = 4.3$. Only small amounts of cyclohexene and cyclohexane-dimers resulted,

but high yield of polymers with more than 12 C-atoms as well as some isomerization products and lower hydrocarbons were produced. In the HT-formation isotope effects were evident. From n-propanol [$G(H_2)$ in vacuo = 3.0], aldehydes, isopropanol and allyl alcohol but no glycols or polymers were formed. While the total decrease of activity in the pure compounds and $G(H_2)$ are strongly dependent on the storing conditions, the radioactivity of the isomerization products formed is rather constant. Benzene and active charcoal are the best protecting media employed. (auth)

12178 RADIOACTIVE KRYPTONATES. I. PREPARATION. D. Chleck, R. Maehl, O. Cucchiara, and E. Carnevale (Parametrics Inc., Waltham, Mass.). Intern. J. Appl. Radiation Isotopes, 14: 581-91(Dec. 1963).

Krypton containing the radioactive isotope Kr^{85} has been stably incorporated into a wide variety of solids. These solid sources, termed kryptonates, were prepared by bombardment with ionized krypton and by diffusion at high temperatures and pressures. Specific activities of 940 $\mu C/cm^2$ and 100 mC/g were prepared. (auth)

12179 RADIOACTIVE KRYPTONATES. II. PROPERTIES. D. Chleck and R. Maehl (Parametrics Inc., Waltham, Mass.). Intern. J. Appl. Radiation Isotopes, 14: 593-8(Dec. 1963).

Krypton containing the radioisotope Kr^{85} can be stably incorporated into a wide variety of solids. This may be accomplished by bombarding the solid with ionized Kr or by diffusion of the inert gas atoms into the solid under high temperature and high pressure. Sources prepared by either means display similar properties. These sources are stable with time at room temperature, and are remarkably stable at elevated temperatures, retaining on the order of half their activity at temperatures within 200°C of the melting point of the solid. The krypton, emplaced by either process, is concentrated near the surface, to a depth of 10^3-10^4 Å making possible high specific activity together with low total activity. Removal or disturbance of the surface by chemical or physical means causes a proportional loss of activity, rendering these sources useful for numerous applications. Reaction behavior of solids with oxygen appeared unchanged by kryptonation through high-temperature high-pressure diffusion. (auth)

12180 THE SYNTHESIS OF C^{14}-CHLORAMPHENICOL. M. S. Ise, R. A. Peabody, and C. Hurwitz (Albany Medical Coll.). Intern. J. Appl. Radiation Isotopes, 14: 615-16 (Dec. 1963).

Carbon-14 was introduced into the dichloroacetyl portion of the chloramphenicol D-three isomer. Methyl dichloroacetate-2-C^{14} was prepared from malonic-2-C^{14} acid dissolved in anhydrous ether. The method for preparation is described. The product had a specific activity of 0.277 μC/mg with an overall isotopic yield of 19.5 percent, and had the same biological activity as authentic chloramphenicol. (H.M.G.)

12181 DEVIATIONS FROM INVERSE SQUARE LAW IN γ-SOURCE STANDARDIZATION. Cs. Ujhelyi (Inst. of Nuclear Research, Debrecen, Hungary). Intern. J. Appl. Radiation Isotopes, 14: 616-18(Dec. 1963).

Investigations were carried out to determine the activity of gamma sources by comparison with a standard of the same isotope. It was concluded that the activity of a gamma source located at a distance r_a (or r) can be determined by comparison with a standard gamma source when the value of $[A(r_a)/A(r)] \cdot (r/r_a)^2$ is known. (P.C.H.)

12182 PREPARATION OF BILIRUBIN LABELED WITH I^{131}. L. J. Anghileri (Volk Radiochemical Co., Skokie, Ill.). Intern. J. Appl. Radiation Isotopes, 14: 630-3(Dec. 1963).

Iodination of bilirubin was carried out using I^{131}. Both iodinated bilirubin and biliverdin were obtained, yields ranged from 7–16 percent and 10–25 percent, respectively. The purity of each radiocompound was determined chromatographically. Normal human serum albumin labeled with radioiodinated bilirubin was prepared and lyophilized. The bilirubin–albumin complex was assayed 24, 48, and 72 hours after preparation. The final product of bilirubin iodination by this technique is a mixture of bilirubin derivatives, one of which is biliverdin. Separation provides a labeled bilirubin that resembles uniodinated bilirubin in physical, chemical, and physiologic characteristics. The method is a relatively inexpensive way of preparing bile pigments that may be used in bilirubin metabolism studies and in liver function tests. (H.M.G.)

12183 THE PREPARATION OF CARRIER-FREE Cl^{36} AND Br^{82}. M. Anbar and P. Neta (Weizmann Inst. of Science, Rehovoth, Israel and Soreq Research Establishment, Rehovoth, Israel). Intern. J. Appl. Radiation Isotopes, 14: 634(Dec. 1963).

Virtually carrier-free Cl^{36} and Br^{82} were obtained with specific activities of 15 mC/g Cl and 3×10^5 mC/mg Br using benzoic acid as scavenger for (n,γ) reactions. (P.C.H.)

12184 EFFECT OF THE PURIFICATION OF SOLVENTS ON THE EFFICIENCY OF LIQUID SCINTILLATORS. [PART] I. C. Tanielian, A. Coche, A. Deluzarche, G. Laustriat, and A. Maillard (Faculte des Sciences, Strasbourg). Intern. J. Appl. Radiation Isotopes, 15: 11-15(Jan. 1964). (In French)

After having analyzed the purity of some commercial samples of toluene, methods used to obtain a very pure solvent are described. A study of the quenching effect of the impurities possibly included in the solvent, enables the relatively small pulse-height amelioration due to purification to be explained. (auth)

12185 EFFECT OF THE PURIFICATION OF SOLVENTS ON THE EFFICIENCY OF LIQUID SCINTILLATORS. [PART] II. C. Tanielian, A. Coche, A. Deluzarche, G. Laustriat, and A. Maillard (Faculte des Sciences, Strasbourg). Intern. J. Appl. Radiation Isotopes, 15: 17-23(Jan. 1964). (In French)

A detailed analysis of the impurities included in several samples of dioxane is presented and the effect of a purification of the solvent on the yield of liquid scintillators is examined. A very important amelioration was observed, due to the strong quenching effect of the impurities. The quenching by peroxides was specially studied. The instability of the dioxane scintillators yield is discussed and convenient purification methods are described. (auth)

12186 PREPARATION OF CARRIER-FREE $S^{35}O_4^{2-}$ AND $H_2S^{35}O_4$. J. O. Abellán, J. Ortega, S. Nunez, and S. N. Cubero (Junta de Energía Nuclear, Madrid). Intern. J. Appl. Radiation Isotopes, 15: 43-7(Jan. 1964). (In French)

A new patent method for producing carrier-free S^{35} is described. Neutron-irradiated KCl is dissolved in distilled water and traces of $S^{35}O_4^{2-}$ and $P^{32}O_4^{3-}$ are precipitated together with barium chromate. The precipitate is then dissolved in a warm aqueous solution of potassium carbonate and this solution is transferred to a balloon-flask containing phosphoric acid and powdered copper. Water is evapo-

rated from this solution and when the sulfuric acid ($H_2S^{35}O_4$) becomes concentrated with respect to water, and the temperature is sufficient, it is reduced by the copper to sulfur dioxide. The sulfur dioxide is carried by a current of nitrogen into an absorber, containing hydrogen peroxide or sodium hydroxide, so as to obtain the sulfur as sulfate or sulfite, respectively. (auth)

12187 MÖSSBAUER EFFECT IN CIS-TRANS ISOMERS. R. H. Herber (Rutgers Univ., New Brunswick, N. J. and Mellon Inst., Pittsburgh) and R. G. Hayter. J. Am. Chem. Soc., 86: 101-2(Jan. 20, 1964).

The Mössbauer spectra of cis- and trans- $[C_5H_5FeCOP(C_6H_5)_2]_2$ and cis- and trans- $[C_5H_5FeCOAs(CH_3)_2]_2$ were examined. The spectra show two well-defined peaks of essentially equal intensity for each case. It was also found that the isomer shift is identical for the cis and trans compounds within the limits of accuracy of the experiment. The resonance effect in the arsenic compounds is lower by a factor of 3-4 than that in the analogous phosphorus compounds. This effect is due to the strong K-edge absorption of the 14.4-kev gamma of Fe^{57} by arsenic. (P.C.H.)

12188 ON THE PROBLEM OF RADIOACTIVE RADIATION OF SULFUR-35 INFLUENCING THE CATALYTIC DEHYDRATION OF CYCLOHEXANOL. A. A. Balandin, Vict. I. Spitsyn, N. P. Dobrosel'skaya, and I. E. Mikhailenko (Moscow State Univ.). J. Am. Chem. Soc., 86: 299-300(Jan. 20, 1964).

The catalytic activity of radioactive and non-radioactive $MgSO_4$ and Na_2SO_4 was studied. It was concluded that decreased catalytic activity of a radioactive catalyst is caused only by the decay of the radioactive isotope. (P.C.H.)

12189 RADICAL AND MOLECULAR YIELDS IN THE γ-RADIOLYSIS OF D_2O AND H_2O VAPOR. J. H. Baxendale and G. P. Gilbert (Univ. of Manchester, Eng.). J. Am. Chem. Soc., 86: 516(Feb. 5, 1964).

A yield of molecular as well as atomic hydrogen in the gamma radiolysis of D_2O and H_2O was confirmed. Experiments were carried out using doses of $1.5-5.5 \times 10^{19}$ ev delivered to the vapor at 116°C and about 60 cm pressure in a 5-l vessel. The values of G(HD) attained limiting values of 10.5 with H_2 but appeared to approach only about 7.0 with CH_3OH or C_2H_6. The formation of D_2 in the presence of high concentrations of H_2 or C_3H_8 can only originate as molecules from D_2O. (P.C.H.)

12190 THE XENON-RADIOSENSITIZED DEUTERIUM–METHANE EXCHANGE. RECOMBINATION RATE CONSTANT FOR DEUTERIUM ATOMS AND METHYL RADICALS. A. Maschke and F. W. Lampe (Pennsylvania State Univ., University Park). J. Am. Chem. Soc., 86: 569-74 (Feb. 20, 1964).

The radioinduced deuterium–methane exchange, sensitized by xenon, is shown to proceed via deuterium atoms and methyl radicals. All deuteriomethanes (d_1-d_4) are formed simultaneously, and, at low partial pressures of deuterium, significant amounts of deuterioethanes, deuteriopropanes, and deuteriobutanes are formed. A kinetic treatment of the deuteriomethane formation results in an estimate of the recombination rate constant for deuterium atoms and methyl radicals that is in good agreement with the specific collision rate assuming a collision diameter of 2.6 Å. (auth)

12191 THE FRAGMENTATION OF SOME BORON HYDRIDES BY ELECTRON IMPACT. T. P. Fehlner and W. S. Koski (Johns Hopkins Univ., Baltimore). J. Am. Chem. Soc., 86: 581-6(Feb. 20, 1964).

The fragmentation of isotopically labeled volatile boron hydrides by electron impact was studied. Monoisotopic spectra, appearance potentials of selected fragments, and metastable transitions are reported both for protonated and deuterated compounds. Ionization potentials are given for diborane, tetraborane, pentaborane-9 and -11, and hexaborane. Heats of formation are calculated for the various fragment ions produced and are used in determining the decomposition paths for the parent ions. Structures of several fragment ions are postulated from data on isotopically labeled hydrides; ionization potentials are calculated from the corresponding appearance potentials. (auth)

12192 ISOTOPIC EXCHANGE OF THE EXCITED OXYGEN ATOMS WITH CO_2^{18} AND THEIR COLLISIONAL DEACTIVATION. H. Yamazaki and R. J. Cvetanović (National Research Council, Ottawa). J. Chem. Phys., 40: 582-5 (Jan. 15, 1964). (NRC-7737)

Isotopic exchange of the excited oxygen atoms produced by photolysis of N_2O at 1849 Å with CO_2^{18} was studied at room temperature. The exchange is strongly suppressed by addition of xenon, and is not affected by SF_6. This provides further evidence for the effective deactivation of the electronically excited oxygen atoms by collisions with xenon atoms, and lack of deactivation on collisions with SF_6 molecules. Relative values of the rates of exchange and deactivation were obtained as well as the relative rate of reaction of the excited atoms with N_2O. (auth)

12193 PARAMAGNETIC RESONANCE SPECTRUM OF IRRADIATED SINGLE CRYSTALS OF L-CYSTINE DIHYDROCHLORIDE. Harold C. Box and Harold G. Freund (Roswell Park Memorial Inst., Buffalo). J. Chem. Phys., 40: 817-21(Feb. 1, 1964).

The principal absorption in the ESR spectrum of single crystals of cystine dihydrochloride irradiated at 77°K is attributed to the free radical $([-S-CH_2-CH(NH_3^+Cl^-)COOH]_2)^+$ in which the unpaired electron is localized primarily on the sulfur atoms. The principal values of the g tensor are 2.017, 2.018, and 2.002. Each of the four CH_2 protons contributes a nearly isotropic hyperfine splitting of approximately 8.5 G. (auth)

12194 ELECTRON SPIN RESONANCE STUDIES OF IRRADIATED SINGLE CRYSTALS OF CREATININE AND CREATINE. Hisashi Ueda (Univ. of British Columbia, Vancouver). J. Chem. Phys., 40: 901-5(Feb. 1, 1964).

The electron spin resonance spectra of x irradiated single crystals of creatinine : creatinine HX (X = HO_3, F, Cl, Br, I, and NO_3) : Ca creatine, and creatine phosphate, were studied at room temperature. The ESR spectrum of an x irradiated single crystal of creatinine at 77°K was also studied. The free radicals formed in these compounds have similar structures to those formed in irradiated N-acetylglycine, glycylglycine, and diketopiperazine. The unpaired electron spin density distribution was computed by a Hückel molecular orbital method using an electronic computer, and was compared with the experimental results. The anisotropic components of the observed splitting factors were relatively smaller in these compounds than those found in N-acetylglycine, glycylglycine, diketopiperazine, and malonic acid. This can be explained by considering the effective nuclear charge on the vicinal nitrogen atom, which will affect the s character of the unpaired electron on the carbon atom, where the electron has main spin density of some 0.5. The free radical, first formed, has a structure in which the unpaired electron is localized on three atoms. This, then, transforms to a delocalized species with a larger conjugated system. The delocalization energy for this transformation is about 8.3 kcal/mole. (auth)

12195 ELECTRON SPIN RESONANCE IN IRRADIATED SINGLE CRYSTALS OF BETAINE HYDROCHLORIDE. Georg Schoffa (Technische Hochschule, Karlsruhe, Ger.). J. Chem. Phys., 40: 908-9(Feb. 1, 1964).

Radicals trapped in electron-irradiated single crystals of betaine hydrochloride, $(CH_3)_3N^+ CH_2COO^-$, were studied. Irradiation was carried out at room temperature with 1 Mev electrons. The dosages ranged from 1 to 5 Mrad and had no apparent effect on the nature of the free radicals formed in betaine. The spectrum along the a axis consists of 30 lines, respectively, 10×3 lines. The first splitting in 10 equally spaced lines of nearly binominal intensity is due to the interaction between the unpaired electron and the nine protons of the methyl groups in betaine radical. Each of these lines is split in a triplet of nearly the same intensity due to the interaction between the unpaired electron and the N^{14} nucleus. The radical in irradiated betaine was identified as $^+N(CH_3)_3$. Evidence is given to indicate that the radical must be planar. (P.C.H.)

12196 DESORPTION FROM SURFACES BY SLOW-ELECTRON IMPACT. Dietrich Menzel and Robert Gomer (Univ. of Chicago). J. Chem. Phys., 40: 1164-5(Feb. 15, 1964).

An adsorbate-covered W field emitter was bombarded from one side with low-energy electrons from a simple gun and changes were looked for visually and by work-function measurements. Beam intensities were determined by replacing the field emitter with a microprobe and were $\sim 10^{-4}$ amp/cm^2 above 10 ev. With hydrogen on W no desorption could be detected at any coverage between 4 and 300°K, with energies from 10 to 200 ev. With oxygen, desorption was detected only from a full layer, deposited by low-temperature spreading and heated to 80°K to evaporate physisorbed oxygen. Desorption was limited to energies >25 ev. The salient feature of the results is the remarkable small reaction cross section, which is $\sim 10^{-4}$ that of ionization or excitation in the gas phase. (P.C.H.)

12197 QUENCHING OF THE SCINTILLATION PROCESS IN PLASTICS BY ORGANOMETALLICS. Stanley R. Sandler and K. C. Tsou (Borden Chemical Co., Philadelphia and Univ. of Pennsylvania, Philadelphia). J. Phys. Chem., 68: 300-4(Feb. 1964).

Organometallics of the group II, IVA, and VA metals were found to be quenchers for the scintillation process in polyvinyltoluene plastics. Copolymerizing vinyltoluene and p-triphenyltinstyrene produced a slight increase in the degree of quenching above triphenyl-4-ethylphenyltin. In addition, copolymerizing p-triphenylleadstyrene with vinyltoluene also produced slightly more quenching than triphenyl-4-ethylphenyllead physically dissolved in the plastic scintillator. A modified Stern–Volmer relationship was used to correlate the scintillation quenching of the organometallics and the atomic number. The mechanism of energy transfer and quenching are discussed in relation to the results found in this investigation. (auth)

12198 THE EFFECTS OF LINEAR ENERGY TRANSFER IN THE RADIATION-INDUCED POLYMERIZATION OF SEVERAL VINYL COMPOUNDS. J. Fock, A. Henglein, and W. Schnabel (Hahn-Meitner-Institut fur Kernforschung, Berlin). J. Phys. Chem., 68: 310-14(Feb. 1964).

The radioinduced polymerization of styrene, methyl methacrylate, and vinyl acetate containing small amounts of triethyl borate was studied. At the same absorbed dose rate, the rate of polymerization by the high LET particles from the reaction $B^{10}(n,\alpha)Li^7$ was found to be much lower than by γ rays, while the average molecular weight of the polymer formed was higher. The results are explained by assuming that only free radicals in the tracks of fast δ-electrons are able to initiate long-chain polymerization. The fraction f of the energy of the heavy particles that is effective in producing polymerization amounts to 0.16 for styrene, 0.09 for methyl methacrylate, and 0.04 for vinyl acetate (if f is made equal to unity in the case of γ rays). It is shown that f decreases with increasing radiation sensitivity (G(R) value) of a monomer. The minimum kinetic energy of the δ-electrons that participate in the initiation of long-chain polymerization is calculated to be 170–240 ev, depending on the nature of the monomer. (auth)

12199 THE GAS PHASE REACTIONS OF RECOIL SULFUR ATOMS WITH CARBON MONOXIDE AND CARBON DIOXIDE. Edward K. C. Lee, Y. N. Tang, and F. S. Rowland (Univ. of Kansas, Lawrence). J. Phys. Chem., 68: 318-22(Feb. 1964).

Recoil S^{35} atoms from the nuclear reaction $Cl^{35}(n,p)S^{35}$ were produced in $CO-C_2F_4Cl_2$ and $CO_2-C_2F_4Cl_2$ gaseous mixtures. Carbonyl sulfide (OCS^{35}) was isolated from each system by radio-gas chromatography. The reaction with CO_2 is probably initiated by an energetic species and accounts for about 2% of the total S^{35}. The reaction with CO is probably a scavenger reaction for thermal S^{35} atoms and accounts for as much as an estimated 85% of the total S^{35} production. The yield is greatly reduced in the simultaneous presence of O_2 and CO. The very high yield of OCS^{35} from CO systems indicates a convenient synthetic method of preparation for this labeled molecule. (auth)

12200 ON THE VISCOSITY OF BRANCHED POLYMERS PRODUCED BY HIGH-ENERGY IRRADIATION. J. G. Spiro, D. A. I. Goring, and C. A. Winkler (McGill Univ., Montreal and Pulp and Paper Research Inst. of Canada, Montreal). J. Phys. Chem., 68: 323-30(Feb. 1964).

Statistical calculations of the intrinsic viscosity of irradiated polymers were extended to study the effects of branching on $[\eta]$. It has become possible to test several theories by comparing calculated and experimental values of $[\eta]$ as a function of dose. It was concluded that formulas derivable from the Flory–Fox and Debye–Bueche treatments over-estimate the influence of branching on viscosity. Zimm and Kilb's approximation gave good agreement with experimental data for solutions of irradiated polymers in poor solvents, while for solutions in good solvents the Stockmayer–Fixman treatment appeared to be better. Although the statistical treatment used was, in principle, limited to polymers of initially random distribution, experimental results obtained for irradiated samples of narrow distribution polystyrene indicate that the effect of molecular weight distribution is small. The fact that none of the above mentioned theories can explain the hydrodynamic behavior of branched molecules in solvents of different types is attributed to the inadequacy of the radius of gyration as a measure of hydrodynamic radius. (auth)

12201 CROSSLINKING AND DEGRADATION IN γ-IRRADIATED POLY-n-ALKYL ACRYLATES. W. Burlant, J. Hinsch, and C. Taylor (Ford Motor Co., Dearborn, Mich.). J. Polymer Sci., Pt. A, 2: 57-67(Jan. 1964).

Polymers of methyl, ethyl, n-butyl, n-octyl, and n-cetyl acrylate were γ-irradiated in vacuo, and the effects of irradiation temperature (−196 to 56°C) on energy yields for crosslinking and degradation estimated from gel fractions and swelling behavior of the gel. The extent of degradation was independent of polymer structure and reaction temperature, suggesting a molecular chain breaking process.

Crosslinking, found to occur predominantly on the alkyl side chain, was independent of temperature above and below the polymer softening point, but was several fold higher for irradiations above the softening point; these data seemed to reflect the importance of segmental mobility of radiation produced polymer radicals in the crosslinking step. (auth)

12202 EFFECTS OF DEUTERATION AND TEMPERATURE UPON THE PHOTOLYSIS OF CELLULOSE IN A VACUUM WITH 2537 A. LIGHT. Joseph H. Flynn and William L. Morrow (National Bureau of Standards, Washington, D. C.). J. Polymer Sci., Pt. A, 2: 91-103(Jan. 1964).

The effects of the exchange of deuterium for hydrogen in the hydroxyl groups on the composition of products and the kinetics of their formation during the irradiation of cellulose by 2537 Å in a vacuum at 77, 313, and 365°K are described. About 50 to 70% of the total hydrogen evolved was HD. Little D_2 was formed. Total HD evolution was independent of temperature. Disproportionation, rather than atom abstraction or atom combination, was considered likely to be the dominant mechanism of hydrogen production. Much of the aldehyde group formation took place during the photolysis and probably resulted directly from secondary photolysis or disproportionation of radicals. H_2, CO, and CO_2 evolutions increased with temperature and resulted from both functional group photolysis and radical depropagation. Chain scission and carboxyl group formation took place to a large extent during the post-irradiative oxidation of long-lived oxygen-containing radicals. (auth)

12203 ELECTRON SPIN RESONANCE OF IRRADIATED SOLUTION-CRYSTALLIZED POLYETHYLENE. R. Salovey and W. A. Yager (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Polymer Sci., Pt. A, 2: 219-24 (Jan. 1964).

If films containing oriented lamellae of solution-crystallized polyethylene were rotated in an external magnetic field, marked anisotropy in electron spin resonance was noted. When the magnetic field was perpendicular to the chains the spectrum consisted of ten lines with a hyperfine component separation of 15 gauss. When the magnetic field was parallel to the chains, the spectrum was a sextet with a splitting of 34 gauss. These splittings were in fairly good agreement with the studies of McConnell et al. on irradiated malonic acid single crystals. The high resolution and stability of electron spin resonance spectra of irradiated polyethylene crystallized from solution suggested greater perfection of crystalline order than in elongated fibers. Moreover, the results on solution-crystallized polyethylene indicated that the alkyl radicals are formed at random in the crystalline matrix. (auth)

12204 MAIN-CHAIN DEGRADATION AND THERMAL STABILIZATION OF POLYOXYMETHYLENE BY IONIZING RADIATION. Sadao Torikai (Toyo Rayon Co., Ltd., Otsu, Shiga, Japan). J. Polymer Sci., Pt. A, 2: 239-52(Jan. 1964).

Polyoxymethylene dihydrate was irradiated in vacuum and in air at room temperature by γ rays from Co^{60}, and the change of its thermal stability was examined. The logarithm of viscosity number decreased linearly with the logarithm of dose both in vacuum and in air. The decomposition curve of irradiated polyoxymethylene in vacuum at 200°C can be divided into two components. The percentage of stable polymer of the irradiated polyoxymethylene dihydrate increased with decreasing solution viscosity, attained a value of 80 to 95%, and was expressed approximately as function of η/η_0. In case of irradiation in air, the stabilization was often invalidated by oxygen. The after-effects of irradiation on the stabilization could not be detected under the irradiation conditions examined in the present study. In decomposition in vacuum at 250°C, the irradiated polyoxymethylene dihydrate showed a curve of three components. It seemed that the irradiated polyoxymethylene dihydrate consists mainly of three kinds of polymer differing in their thermal stabilities. The most stable polymer comprised about one-fourth of total stable polymer. These facts might be explicable with the formation of formyloxy and methoxy endgroups by the disproportionation reaction of radicals produced primarily by main chain scissions. The inclusion of stable polymer before irradiation was noted in the case of the polyoxymethylene produced in the post-polymerization of irradiated solid formaldehyde. (auth)

12205 RADIATION-INDUCED POLYMERIZATION OF OCTAMETHYLCYCLOTETRASILOXANE. Y. Tabata, H. Kimura, and H. Sobue (Tokyo Univ.). J. Polymer Sci., Pt. B, 2: 23-5(Jan. 1964).

The radioinduced polymerization of octamethylcyclotetrasiloxane is described. For solid state polymerization in the vicinity of the melting point, polymerization yields increase with the irradiation dose. At low irradiation doses, only soluble polymer forms, and at higher irradiation doses, the more crosslinked polymer comes to form. Overall activation energy in the vicinity of the melting point was about 40 kcal/mole. The results show that the polymerization reaction could take place only at a narrow temperature region near the melting point, in which two factors, mobility and orientation of the molecule, would be satisfied for the polymerization. (P.C.H.)

12206 A REMARK ON THE CAUSE OF SATURATION IN γ-RAY IRRADIATION POLYMERIZATION OF 3,3-BISCHLOROMETHYLCYCLOXABUTANE. Tsutomu Kagiya, Masatsugu Izu, and Kenichi Fukui (Kyoto Univ.). J. Polymer Sci., Pt. B, 2: 93-6(Jan. 1964).

A polymerization study of 3,3-bis-chloromethylcycloxabutane showed that the saturation phenomena could not be observed in the use of a purified monomer, and the overall process was found to follow a first-order rate equation even in the use of a monomer of microcrystalline form. The intentional introduction of some additive species or impurities into the monomer gave rise to the saturation phenomena. The results demonstrate that this fact could be explained by a certain ground of some chemical origins. Water and sym-dichloroacetone were designated as the possible compounds to be accountable for the phenomena. (P.C.H.)

12207 EVIDENCE FOR AN IONIC MECHANISM IN THE RADIATION-INDUCED POLYMERIZATION OF ISOBUTYL VINYL ETHER. Michael A. Bonin, Mary Louise Calvert, W. Lamar Miller, and Ffrancon Williams (Univ. of Tennessee, Knoxville). J. Polymer Sci., Pt. B, 2: 143-9(Jan. 1964).

The rate of polymerization of liquid isobutyl vinyl ether conforms to an Arrhenius temperature dependence with an overall activation energy of 6.6 kcal/mole between −78 and 90°C. Also, it was found that the rate of polymerization at 30°C depends on the 0.65 power of the dose rate. Evidence was obtained that such results do not preclude an ionic mechanism. By studying the effect of added ion (proton) scavengers in very low concentration on the rate of polymerization, it was established that ions play the predominant role as chain intermediates. The effectiveness of ammonia as a retarder for the polymerization indicates that the reaction is cationic. (P.C.H.)

12208 INTERNATIONAL SYMPOSIUM ON MACROMOLECULAR CHEMISTRY, PARIS 1963. PART 2. M. Magat, ed. J. Polymer Sci., Pt. C, No. 4, 767-1494 (1963). New York, Interscience Publishers, 1963.

Fifty-seven papers presented at the International Symposium on Macromolecular Chemistry are presented. Topics covered include: polymerization in the solid state, polymerization under unusual conditions and with new catalysts, and electronic properties of natural and synthetic polymers. Separate abstracts were prepared for 18 papers. (M.C.G.)

For abstracts of individial papers see: 12209, 12210, 12211, 12212, 12213, 12214, 12215, 12216, 12217, 12218, 12219, 12220, 12221, 12222, 12223, 12224, 12225, and 12226.

12209 POLYMERIZATION IN THE CRYSTALLINE STATE. IV. CALCIUM ACRYLATE AND BARIUM METHACRYLATE. Jerome B. Lando and Herbert Morawetz (Polytechnic Inst. of Brooklyn). J. Polymer Sci., Pt. C, No. 4, 789-803(1963).

Different crystalline and amorphous modifications of calcium acrylate in anhydrous and hydrated form and barium methacrylate dihydrate were irradiated at -78°C, with gamma rays and their post-polymerization at 50 and 100°C was studied. With calcium acrylate the anhydrous crystalline salt and the dihydrate could be polymerized while the monohydrate was inert. Two different crystalline modifications of the anhydrous salt behaved quite differently, and the polymerization rate of the anhydrous amorphous salt depended on the hydrate form from which it originated. The crystal structure of calcium acrylate dihydrate was determined and it showed that the reactive double bonds lie in sections of 3 Å thickness, separated from each other by a distance of 7 Å. The polymerization of barium methacrylate dihydrate led to a polymer that was much less syndiotactic than poly(methacrylic acid) prepared in solution. The tacticity of this polymer depended markedly on the molecular weight at 25.5 and 50°C, presumably because the restraints imposed by the crystal lattice of the monomer decreased during the polymerization. The molecular weight of the polymer obtained at 50°C was proportional to the monomer conversion. A preliminary crystallographic analysis indicated that barium methacrylate dihydrate has a structure similar to that of calcium acrylate dihydrate. (auth)

12210 STRUCTURE OF POLYMERS FORMED BY RADIATION-INDUCED SOLID-PHASE POLYMERIZATION OF CYCLIC MONOMERS. K. Hayashi, M. Nishii, and S. Okamura (Japanese Assn. for Radiation Research on Polymers, Osaka and Kyoto Univ.). J. Polymer Sci., Pt. C, No. 4, 839-48(1963).

The structure of polymer obtained by γ-radiation-induced solid-state polymerization was examined by x-ray diffraction analysis. The polymers of 3,3-bischloromethylcycloxabutane, trioxane, and tetraoxane were shown to have an oriented mosaic structure of twin crystallites, of which two polymers of oxymethylene were in helical configuration. The polymer of β-propiolactone was not in the twin crystal form. Two kinds of polymers obtained from β-propiolactone and 3,3-bischloromethylcycloxabutane were found to be in planar zigzag configuration. (auth)

12211 EFFECT OF POLYMORPHISM IN SOLID-STATE POLYMERIZATION. Catherine S. Hsia Chen and Donald G. Grabar (American Cyanamid Co., Stamford, Conn.). J. Polymer Sci., Pt. C, No. 4, 849-68(1963).

The influence of polymorphism of the monomer in solid state polymerization was demonstrated by comparing the polymerization behavior of two crystalline modifications of tributylvinylphosphonium bromide. Both modifications were found to polymerize at fast rates to give amorphous polymers, and the unstable modification to polymerize faster than the stable modification under all the experimental conditions investigated. Both crystalline modifications appeared to polymerize by the same mechanism and follow the same kinetics as evidenced by the nature of inhibition and acceleration by oxygen, by their conversion-time curves, and by their dose rate dependence. The overall activation energies for the polymerization were found to be the same for both forms. The faster rates of the unstable form are attributed primarily to the steric and collision factors in the Arrhenius equation, which are governed by the crystal structure of the two polymorphs. The rate of polymerization was determined to be independent of crystal size. The stable form was found to polymerize at equal rates in all crystallographic directions. (auth)

12212 COPOLYMERIZATION IN SOLID SOLUTIONS. Catherine S. Hsia Chen and Donald G. Grabar (American Cyanamid Co., Stamford, Conn.). J. Polymer Sci., Pt. C, No. 4, 869-80(1963).

Tributylvinylphosphonium bromide was found to be isomorphous with tributylvinylphosphonium iodide. Their solid solutions were characterized microscopically and by x-ray diffraction. X-ray-initiated polymerization of the pure iodide and copolymerization of six solid solutions of different compositions of the two monomers were investigated over the temperature range from 60 to -80°C. S-shaped polymerization rate curves were obtained. Generally the polymerization rates of intermediate compositions were found to be intermediate between the two pure monomers. However, some compositions rich in the bromide exhibited slower rates than either pure monomers. The apparent activation energies for polymerization increased with increased bromide/iodide ratios, and in a manner analogous to the effect of composition on the melting behavior of the solid solutions. (auth)

12213 RADIOPOLYMERIZATION OF SOLID ACRYLONITRILE: EFFECT OF CRYSTALLIZATION CONDITIONS AND PHASE TRANSITIONS. R. Bensasson, A. Dworkin, and R. Marx (Faculté des Sciences, Orsay France). J. Polymer Sci., Pt. C, No. 4, 881-95(1963). (In French)

The specific heat of solid acrylonitrile was studied between -196 and -83°C after solidification with different methods. The influence of the crystallization and of the phase transition conditions on the yield of polymer and the heat evolution after irradiation of this monomer in solid state were examined. It is shown that phase transitions explain the kinetic and calorimetric results. (auth)

12214 RADIATION-INDUCED SOLID-PHASE POLYMERIZATION. I. POLYMERIZATION OF ACRYLONITRILE. I. M. Barkalov, V. I. Goldanskiĭ, N. S. Enikolopyan, S. F. Terekhova, and G. M. Trofimova (Inst. of Chemical Physics, Moscow). J. Polymer Sci., Pt. C, No. 4, 897-908(1963).

Radioinduced polymerization of solid and liquid acrylonitrile (AN) at -196 to 0°C was studied. A diathermic calorimeter was used to determine whether polymerization takes place in the solid state during irradiation or during the subsequent heating. The presence of active centers during irradiation of AN at different temperatures and their disappearance after irradiation was detected by

the ESR (electron spin resonance) method. Post-polymerization kinetics was studied as well. In AN at <–140°C (phase-transition point), solid-state polymerization took place only during irradiation. There was a certain limiting polymer yield, and no post-effects were observed in spite of persistence of the shape and intensity of the ESR signal after the end of irradiation. The activation energy of solid-state polymerization of AN was zero up to the melting point (–82°C). At temperatures greater than –140°C, the AN polymer yield in the solid state was no longer limited, and post-polymerization took place. Its activation energy (~3 kcal/mole) was the same as for the polymerization in the liquid phase. Thus, the solid-state post-polymerization mechanism was similar to that of the liquid-state process, and differed from that of the solid-state polymerization during irradiation. These facts were considered evidence for specificity of radiation-induced solid-state polymerization during irradiation. The high efficiency of such polymerization was probably caused by the formation of short-lived excited molecular states. Such states decay soon after the end of the solid-state irradiation (although the ESR signal persists) and for the liquid phase their steady-state concentrations during the irradiation are much less due to increase in the quenching rate. Such active centers can be much more effective than ions or radicals in the energy-chain propagation of solid-state polymerization as suggested by Semenov. (auth)

12215 RADIATION-INDUCED SOLID-PHASE POLYMERIZATION. II. POLYMERIZATION OF VINYL ACETATE. I. M. Barkalov, V. I. Goldanskiĭ, N. S. Enikolopyan, S. F. Terekhova, and G. M. Trofimova (Inst. of Chemical Physics, Moscow). J. Polymer Sci., Pt. C, No. 4, 909-21 (1963).

The radioinduced polymerization of vinyl acetate (VA) was studied in the liquid phase and two solid phases (glass-like and crystalline) over the temperature range of –196 to 0°C. A calorimetric technique was used to determine whether polymerization takes place in the solid state or during subsequent heating; the presence of active centers during irradiation and their disappearance after irradiation was followed by the ESR method. Post-polymerization kinetics were also studied. The activation energy for VA polymerization was 3.7 kcal/mole for the liquid phase and zero for the solid phase. No post-effects occurred in the solid state for VA up to the melting point. Unlike the case with acrylonitrile, an increased radiation dose did not result in the occurrence of a limiting polymer yield. In crystalline, as well as in the glassy state the polymerization of VA took place only during irradiation, without activation energy, and ended with the switching off of the beam, in spite of the persistence of the shape and intensity of the ESR signal. Solid-state and liquid-phase investigations on the temperature dependence of polymerization rate for methyl methacrylate, formaldehyde, isobutene, and phenylacetylene showed that for the first two the temperature dependence is of the same nature as for VA and acrylonitrile. For isobutene, there was a maximum polymerization rate close to the melting point. A low activation energy was observed for phenylacetylene over the whole temperature range from –196 to +85°C for both solid and liquid phases. These data support the concept of specificity of solid-state polymerization during irradiation. Such polymerization may be favored by formation of short-lived excited states participating in the development of energy chains, by the motion of molecules upon electron impact, the defreezing of rotation, and excitation of molecular vibrations along tracks of primary and δ-electrons. (auth)

12216 INVESTIGATIONS IN THE FIELD OF RADIATION-INDUCED SOLID-STATE POLYMERIZATION. Gy. Hardy, K. Nyitrai, J. Varga, G. Kovács, and N. Fedorova (Research Inst. of the Plastics Industry, Budapest). J. Polymer Sci., Pt. C, No. 4, 923-34(1963).

Radiation polymerization kinetics of cetyl methacrylate, N-vinylsuccinimide, and N-vinylcaprolactam were investigated in the liquid and solid state. In the solid state each monomer exhibited a different temperature dependence of polymerization rate. This can be caused by the difference in the crystalline structures (different orientation of the monomer molecules in the lattice). In the solid-state polymerization and post-polymerization of N-vinylsuccinimide two cases could be distinguished depending on such parameters as temperature, dose rate, and sample dimensions: the case of thermal steady-state polymerization and the case of thermal explosion. N-Vinylcaprolactam polymerized very slowly in the solid state, while in the supercooled state quite high polymerization rates were found. Slow supercooling resulted in polymerization rates about twice as high as fast supercooling does. (auth)

12217 POLYMER FRACTIONATION STUDIES IN THE SOLID-STATE POLYMERIZATION OF ACRYLAMIDE INITIATED BY GAMMA RADIATION. Bahattin Baysal (Middle East Technical Univ., Ankara). J. Polymer Sci., Pt. C, No. 4, 935-41(1963).

Kinetic studies were previously published on both the in-source and post-irradiation reactions of acrylamide. Two different approaches were adopted in kinetic interpretations: one was that of conventional polymer chemistry and the other was that of solid-state chemistry. It was claimed that the initial number of chains would be constant throughout the post-irradiation polymerization of crystalline acrylamide and consequently the initial free radical concentration could be calculated from the yield and molecular weight data. It was difficult to reconcile such a picture with the proposed nucleation mechanism. Consequently, fractionation studies were made on polymer from both in-source and post-irradiation experiments with the hope that the resultant data might further clarify the issue. Preliminary results indicated the occurrence of a significantly large percentage of polymer of constant molecular weight from the post-irradiation experiment. Further fractionation data are presented, which support the proposed nucleation mechanism for the solid-state polymerization of acrylamide. (auth)

12218 RADIATION-INDUCED STEREOSPECIFIC POLYMERIZATION OF ISOCYANATE IN THE SOLID STATE. Hiroshi Sobue, Yoneho Tabata, and Masahiko Hiraoka, and Keichi Oshima (Tokyo Univ.). J. Polymer Sci., Pt. C, No. 4, 943-51(1963).

Radioinduced solid-state polymerizations of isocyanates are reported. It was found that stereospecific polymerization is possible during solid-state polymerization at low temperature. Stereospecific crystalline polymer was obtained from the solid-state polymerization of butyl isocyanate. On the other hand, when the monomer was polymerized in the liquid state, the polymer obtained was amorphous and quite different from that obtained in the solid state. Several other isocyanates were polymerized in both liquid and solid states. Crystalline polymers could not be obtained. (auth)

12219 RADIATION-INDUCED IONIC POLYMERIZATION OF STYRENE: EFFECTS OF ADDITIVES. A. Charlesby and J. Morris (Royal Military Coll. of Science, Shrivenham, Wilts, Eng.). J. Polymer Sci., Pt. C, No. 4, 1127-33(1963).

When styrene in dichloromethane solution was irradiated at −78°C, the resulting polymerization occurred via an ionic mechanism. It was previously shown that the yields in this reaction can be greatly enhanced by the addition of finely divided solids such as Aerosil. Additives studied included a number of silica powders whose surfaces were modified by the replacement of hydroxyl groups by alkyl, allyl, and aryl groups. It was found that the "catalytic power" of these silicas can be correlated with the nature and number of substituted groups. Although the polymerization is cationic in character, the presence of excess electron trapping material (tetracyanoethylene) caused a diminution of yield. Electrical conductivity measurements on the polymerizing solution, in the presence and absence of additives, were made to clarify the proposed reaction mechanism. (auth)

12220 RADIOCHEMICAL POLYMERIZATION OF ISOBUTENE IN THE PRESENCE OF SOLID ADDITIVES. C. David, F. Provoost, and G. Verduyn (Centre d'Etudes de l'Energie Nucléaire, Mol, Belg.). J. Polymer Sci., Pt. C, No. 4, 1135-49(1963). (In French)

Several recent works showed that the polymerization of isobutene initiated by gamma-rays in liquid homogenous medium at −80°C proceeds through a cationic mechanism; moreover, the reaction is strongly accelerated by the presence of finely dispersed ionic solids. Several solids were tested, as e.g., semiconductors n and p, isolators such as α-Al_2O_3, colloidal gold, and graphite. The catalytic effect was generally observed, whatever the electrical properties and the chemical structure of the substances. A detailed study was carried out with α-Al_2O_3. The overall rate of polymerization increased with the temperature between −110 and 0°C when the reaction was carried out in the presence of additive. It diminished with the temperature for the same reaction in homogeneous phase. The molecular weight of the sample obtained in heterogeneous system decreased with the temperature. The study of the composition of isobutene-vinylidene chloride copolymers prepared at −80°C confirmed, nevertheless, the existence of a cationic mechanism. The effects of the length of irradiation, the gamma intensity, and the specific surface and of the volume of the additive were considered, as well as the chain transfer possibility. An ultraviolet mercury band was used as initiator for the polymerization of isobutene at 0°C in homogenous system, and in the presence of zinc oxide and aluminum oxide. A mechanism is proposed in function of these kinetic data and of the electronic excitation spectrum of the solids. (auth)

12221 RADIATION-INDUCED POLYMERIZATION AT HIGH PRESSURES. Leo A. Wall and Daniel W. Brown (National Bureau of Standards, Washington, D. C.). J. Polymer Sci., Pt. C, No. 4, 1151-60(1963).

Several radioinduced polymerization reactions were investigated at pressures between 5,000 and 17,000 atm and temperatures between 20 and 275°C. The most detailed studies were with propylene and n-tetradecafluoroheptene-1. With both monomers the variation of rate of polymerization, R_p, with temperature and radiation intensity was consistent with a free radical mechanism. The maximum number of monomer units converted to polymer per 100 ev absorbed, G(M), was 108,000 and 7,600 in the polymerization of propylene and the heptene, respectively; thus, the kinetic chains are long. However, the number-average degree of polymerization, DP_n, was low, the maximum values being about 75 in both polymerizations. In the polymerization of propylene, transfer to monomer limited DP_n; the transfer constant became greater as temperature increased or pressure decreased. In the polymerization of the heptene, DP_n was determined by both transfer and termination. In the latter polymerization both R_p and DP_n first increased and then decreased as the temperature was raised at constant pressure because the depolymerization rate became appreciable at high temperature and reduced the observed R_p. (auth)

12222 GRAFTING OF STYRENE ONTO TEFLON AND POLYETHYLENE BY PREIRRADIATION. J. Dobó, A. Somogyi, and T. Czvikovszky (Research Inst. for the Plastics Industry, Budapest). J. Polymer Sci., Pt. C, No. 4, 1173-93(1963).

The use of classical equations of polymerization kinetics gives a fair approximation for describing the grafting process on trapped free radicals in some heterogeneous systems. Initiation corresponds to the addition of the first monomer molecules to the trapped radicals. As a result of diffusion effects, the activation energies of initiation and termination were higher than expected. E_i was found to be 13 kcal/mole for styrene in Teflon and 14.6 kcal/mole in polyethylene, while E_t was 11.4 and 12.5 kcal/mole, respectively. In Teflon, grafting was shown to begin at the surface and to take place in a relatively narrow traveling front. When the whole film was grafted through, the reaction slowed down and came to an end. In grafting onto polyethylene there was a spontaneous grafting of constant rate onto the unirradiated films, with an apparent activation energy of 12.4 kcal/mole. (auth)

12223 COMPARISON OF RADIATION- AND PEROXIDE-INITIATED GRAFTING OF STYRENE TO POLYETHYLENE FILM. William K. W. Chen and Henry Z. Friedlander (American Machine and Foundry Co., Springdale, Conn.). J. Polymer Sci., Pt. C, No. 4, 1195-1209(1963).

Polyethylene films were modified by grafting with styrene by the following means: gamma radiation from Co^{60} source with film immersed in liquid monomer; beta radiation in air followed by contact with liquid monomer; and treatment with liquid monomer containing benzoyl peroxide. The rates of polymerization, the degree of actual covalent grafting, and mechanical properties are discussed with regard to crystallinity of the starting film, the level of grafting, and initiation rate. It was found that the amount of actual covalent bonding determined by fractional precipitation was the least by the peroxide method and the most by the beta-irradiation method. Methods using gamma radiation or peroxide yielded products soluble in hot xylene. It was also found that homopolymeric styrene separated from the interior of the grafted film has a considerably higher molecular weight than that formed in the surrounding bath (Trommsdorff effect). Films of low crystallinity (density = 0.91 g/cm^3) showed a high level of microheterogeneity when prepared by the peroxide method. This phenomenon did not occur with films of higher crystallinity (density = 0.93 to 0.96 g/cm^3). It is shown that this effect is related to the diffusion of oxygen into the film. The amount of grafting is shown to be relatively independent of the level of preirradiation in the range of 10 to 20 Mrad. (auth)

12224 GRAFTING OF STYRENE-ACRYLONITRILE ONTO POLYVINYLCHLORIDE BY A DIRECT RADIOCHEMICAL METHOD. Adolphe Chapiro and Anna-Maria Jendrychowska-Bonamour (Centre National de la Recherche Scientifique, Bellevue, France). J. Polymer Sci., Pt. C, No. 4, 1211-22(1963). (In French)

The radiochemical grafting of mixtures of styrene and acrylonitrile into PVC (polyvinylchloride) films at 20°C was studied. It was found that the degree of swelling of

PVC is appreciably more pronounced in some mixtures than in one of the pure monomers. The swelling was maximum in a mixture containing 30% acrylonitrile. The curve representing the rate of grafting as a function of the composition of the monomer mixture showed a complex shape. Study of the radiochemical copolymerization of both of these monomers showed that this complexity is partly due to the precipitation of the copolymer in the reaction medium for acrylonitrile contents higher than 95%. Differences observed between grafting and copolymerization curves were interpreted on the basis of perturbations of the grafting, due to gel effect and to the diffusion of the monomers. When the reaction conditions were such that the grafting kinetics were not diffusion controlled, then the composition of the grafts was similar to that of the statistical copolymer obtained in the mixture of the two monomers. (auth)

12225 GRAFTING ON POLYPROPYLENES OF DIFFERENT MICROSTRUCTURES. Frederic Geleji and Louise Ódor (Plastics Research Inst., Budapest). J. Polymer Sci., Pt. C, No. 4, 1223-32(1963).

In previous investigations the γ-induced grafting of several monomers onto polypropylene monofilaments and fibers was studied. The unoriented polypropylene fibers, monofilaments, and films, which were prepared without stretching, could be grafted to a greater extent with fibers and films with an oriented microstructure. The change in grafting ability was measured as a function of the crystallinity of the samples. Fibers and films with different crystallinities and orientations were achieved by alternating the method of preparation and the degree of stretching (orientation). By alternating the diameter of monofilaments, varying the temperature of the production of the samples, and working with different draw ratios materials were obtained in which the degree of crystallinity, size of crystals, and degree of orientation was different. The samples were irradiated with γ rays from a Co^{60} source. For grafting materials acrylic acid and methyl methacrylate were used. Also in studying the grafting reaction the peroxide and hydroperoxide contents of the irradiated samples were measured by means of iodometric analysis and infrared spectroscopy. The quantity of free radicals induced by the radiation was followed by the electron spin resonance method. With the two methods the rate of the appearance and disappearance of free radicals in the irradiated matter and the rate of formation and the stability of peroxide and hydroperoxide groups could be followed. The rate of the penetration of the grafted frontier into polypropylene fibers of different degrees of crystallinity was investigated; this was a function of the rate monomer diffusion velocity and the concentration of free radicals or peroxide (hydroperoxide) groups inside the samples. All of these circumstances were investigated as function of the mechanical properties, dyeability, and water absorption of grafted polypropylene fibers. (auth)

12226 RADIATION-INDUCED GRAFT COPOLYMERIZATION ONTO CELLULOSE AND POLYVINYL ALCOHOL FIBERS WITH BINARY MIXTURES OF COMONOMERS. Ichiro Sakurada, Toshio Okada, Shigeyuki Hutakeyama, and Fujiko Kimura (Kyoto Univ.). J. Polymer Sci., Pt. C, No. 4, 1233-49(1963).

Experiments on radioinduced graft copolymerization of binary mixtures such as butadiene–styrene, butadiene–acrylonitrile, styrene–acrylonitrile and some other systems onto cellulose and PVA (polyvinyl alcohol) fibers were carried out with the use of methanol as a solvent. A very marked maximum of graft was observed in every case at a certain composition of the comonomer mixture. It seemed that such a marked maximum was closely connected with popcorn polymerization for the case of butadiene–styrene, but popcorn polymerization was not a necessary condition for the appearance of the maximum. Only a combined effect of swelling of the gel, formation of radicals in the gel, homocopolymerization, and some other unknown factors is considered likely to lead to a very high degree of grafting. (auth)

12227 STUDIES ON X-AGENT. XII. STRIPED PATTERNS PRODUCED IN KAOLIN SUSPENSIONS. Hideo Moriyama (Shonan Hygiene Inst., Kamakura, Japan). Japan J. Microbiol., 5: 103-16(1961).

Effects of the hypothetical X-agent, said to be a high-energy radiation factor of cosmic origin, on 0.1% aqueous suspensions of kaolin are reported. It was found that striped patterns were produced in the suspensions allowed to stand for a few days at room temperature. The pattern formed varied with time and place. Formation of the patterns was inhibited when the glass vessels containing the kaolin suspension were covered with a lead shield of 5-cm thickness. Sometimes even covering with such light materials as paper caused inhibition. Thermal radiation emitted from an electric heater could sometimes enhance the formation of a pattern when employed in low intensity, but when applied at a greater intensity the pattern was strongly disturbed. Softer components of the X-agent are said to be concerned in the formation of the pattern, although it was not determined whether or not harder components are also involved. The inhibition of pattern formation by covering with light materials is attributed to the elimination of very soft components, similar to those of thermal radiation. Evidence is offered that a magnet can interfere with the formation of the pattern, indicating that some electrically charged particles are involved in its formation. Known electrically charged particles emitted by radioisotopes appeared not to be involved. It is proposed that layers of clouds in the upper sky may be produced by the X-agent in a manner in which the striped patterns are formed in kaolin suspensions. (BBB)

12228 METHOD OF DIRECT PRODUCTION OF SODIUM, POTASSIUM, CADMIUM, AND IRON SULFIDES LABELLED WITH S^{35} IN TREATING THE NEUTRON-IRRADIATED KCl TARGET. M. Kucharski and R. Plejewski (Inst. for Nuclear Research, Warsaw). Kernenergie, 6: 701-4 (Dec. 1963). (In German)

For the preparation of S^{35}-labeled sulfides, a method is described, which is based on the nuclear reaction $Cl^{35}(n,p)S^{35}$ as well as the chemical reduction of sulfate ions to sulfide ions. It is different from known methods by means of some changes with regard to starting materials, the concentration of the HI used, the composition of the absorption agent mixture, etc., which facilitate the technological execution of the processes. (tr-auth)

12229 GRAFT COPOLYMERIZATION OF ACRYLONITRILE ON PRE-IRRADIATED POLYETHYLENE IN THE SWELLING SYSTEM. Tsutomu Watanabe and Isamu Ito (Sumitomo Bakelite Co., Ltd., Yokohama, Japan). Kogyo Kagaku Zasshi, 66: 850-3(June 1963). (In Japanese)

When graft copolymerization of acrylonitrile on pre-irradiated polyethylene was carried out in dimethylformamide, the degree of grafting obtained was very low. The total activation energy of grafting was 9.8 kcal over a wide temperature range, from 80 to 140°C. No diminution of the crystallinity of grafted polyethylene was observed in the

x-ray diffraction pattern. The content of grafted acrylonitrile determined by nitrogen analysis was different from that calculated from the weight increment. As the degree of grafting increased, the solubility of grafted polyethylene in xylene at 70°C decreased and the softening point increased. The effect of dimethylformamide on the kinetics of grafting and the relation between solubility and frequency of grafting of these graft copolymers were discussed. (BBB)

12230 RADIATION-INDUCED POLYMERIZATION OF METHYL METHACRYLATE-BORON FLUORIDE COMPLEX IN THE SOLID STATE. Yoshimitsu Takeda, Teiji Tsuruta, Junji Furukawa, and Tomie Amari (Kyoto Univ.). Kogyo Kagaku Zasshi, 66: 1233-40(Aug. 1963). (In Japanese)

A complex is formed by methyl methacrylate acting as electron donor toward BF_3. The 1:1 complex has a melting point of 33.5-33.6°C. When this complex was irradiated with Co^{60} γ rays in the solid state, polymerization occurred and persisted after irradiation. A kinetic study of the post-irradiation polymerization indicated that the reaction proceeded under a nonstationary condition of radical concentrations and that the rate-determining step was the transformation of frozen radicals to active radicals. The appearance of polymerization samples underwent little change during or after irradiation polymerization. The x-ray diffraction pattern, however, showed that all the polymers obtained were amorphous in structure. Several polymer samples gave a unique infrared absorption spectra which differed remarkably from the spectrum of conventional amorphous polymethyl methacrylate. This abnormality was ascribed to this unique conformation of the high polymer, and may have arisen from a specific crystalline structure of the monomer complex during polymerization. (BBB)

12231 RADIOLYSIS OF CYCLOHEXANE + BENZENE MIXTURES AT LIQUID NITROGEN TEMPERATURE BY COBALT-60 γ-RAYS. Jerzy Kroh and Stefan Karolczak (Technical Univ. of Lodz, Poland). Nature, 201: 66-7 (Jan. 4, 1964).

The mechanism of energy transfer in radiolysis of cyclohexane and benzene mixtures in the solid phase is being investigated. The mixtures were irradiated at liquid nitrogen temperature by Co^{60} gamma rays at a rate of 3.3×10^{15} ev ml^{-1} sec^{-1}. In a plot of $G(H_2)$ against the composition of $C_6H_6 + C_6H_{12}$ mixture, three fragments were distinguished in a curve very different from that for the liquid phase. (M.C.G.)

12232 ELECTRON SPIN RESONANCE INVESTIGATIONS OF RADIATION-INDUCED FREE RADICALS IN DNA AND RNA AT LOW TEMPERATURES: EFFECTS OF WATER. Raymond A. Patten and Walter Gordy (Duke Univ., Durham, N. C.). Nature, 201: 361-3(Jan. 25, 1964).

Samples of DNA and RNA were irradiated with a 700°C Co^{60} source directly in an absorption cell, which was maintained at a temperature of 4.2°K. Dosages of the order of 10^6 rads were given. Electron spin resonance observations were made at the same temperature, at a frequency of 23 kMc. The electron spin resonance signals for pure DNA and RNA (with no water) are similar to those found at room temperature, only much stronger for the same dosage of radiation. When the samples irradiated at 4.2°K were allowed to warm to room temperature, spin-recombination reduced the electron spin resonance signal to that obtained after irradiation of the samples with the same dosage at room temperature. A marked decrease in the formation of free radicals from DNA and RNA was found when the water concentration is increased above 50% (by weight). The effects of water indicate transfer of energy from the nucleic acid to the water matrix. Hydrogen-atom and Mn^{2+} resonance in the nucleic acid-water complex are discussed. (P.C.H.)

12233 PULSE RADIOLYSIS. J. H. Baxendale (Univ. of Manchester, Eng.), E. M. Fielden, C. Capellos, et al. Nature, 201: 468-70(Feb. 1, 1964).

Results are given for pulse radiolytic investigation of the nature and reactivity of free radicals in aqueous and non-aqueous systems. Irradiation was by 4-Mev electrons for 2μsec. Results are given for hydrated electrons, inorganic and organic solutions, the scavenging of cyclohexyl radicals by iodine, and for aromatic compounds. 21 references. (R.E.U.)

12234 NON-STATIONARY REACTION RATES IN A RADIATION-INDUCED CHEMICAL REACTION BY MEANS OF CONDUCTIVITY MEASUREMENTS. A. Lotz (Max-Planck-Institut für Biophysik, Frankfurt am Main) and K. Schmidt. Nature, 201: 493-5(Feb. 1, 1964).

The nonstationary processes of the formation of HCl in aqueous solutions of chloral hydrate by x radiation were followed by conductivity variations to measure the lifetimes of intermediates in the reaction. (R.E.U.)

12235 EFFECTS OF LOW-DOSAGE GAMMA-RADIATION ON SOLUBLE COLLAGEN. L. Welling and S. Bakerman (Univ. of Kansas, Kansas City). Nature, 201: 495-6(Feb. 1, 1964).

Sample preparation and examination are discussed. A mechanism for molecule fragmentation is proposed. (R.E.U.)

12236 RADIATION CHEMISTRY OF HYDROCARBONS. Ffrancon Williams (Univ. of Tennessee, Knoxville). Quart. Rev. (London), 17: 101-32(1963).

Fundamental aspects of production of free radicals from organic molecules by ionizing radiations and the potential reactivity of such excited states for large polyatomic molecules are discussed. An outline is given of the quantitative theory of molecule-ion reactions, with particular emphasis on the rates and energetics of the unimolecular and bimolecular processes that lead to the formation of molecules, uncharged free-radicals, and secondary ions. The historical development of radiation chemistry is also considered as well as the shifting interests and interpretations that have marked the growth of this subject. The concept of the G value is discussed and a consideration of theories developed to explain primary radiation reactions leads to the conclusion that reaction mechanisms based on neutral free radicals alone can often provide a superficial explanation of the gross results without revealing the more subtle and hidden factors that operate. Present knowledge of elementary reactions is discussed with special consideration of the formation and dissociation of polyatomic ions, ion-molecule reactions, neutralization of ions, and electronic excitation processes. Basic criticisms are directed at the Eyring quasi-equilibrium unimolecular rate theory: first, that the assumption as to rapid energy randomization may not apply strictly to molecules with less than about 6 atoms, for then the electronic levels will tend to be more discrete; secondly, that energy exchange between vibrational modes of different symmetry properties may be forbidden. For quantitative discussion on the applicability of the theory, the simple classical form of the unimolecular rate constant is used. Experimental data and interpretations relating to radiation reactions in gas, liquid, and

polymeric phases are reviewed. From a consideration of data from radiolysis of alkanes, it was concluded that consideration of the possible dissociation paths of the alkane parent ion, and of the ion-molecule reactions of fragment ions, serves as a useful guide in accounting for product distribution. Postulated mechanisms involved in cross-linking and chain-breaking reactions in irradiated polymers are reviewed and evaluated. (TCO)

12237 RADIOLYSIS OF VARIOUS AROMATIC ALCOHOLS. Dale E. Van Sickle and Harry E. Redeker (Stanford Research Inst., Menlo Park, Calif.). Radiation Res., 21: 256-66(Feb. 1964).

Three dihydroxydiphenylmethanes and three related phenolic compounds have been subjected to 1-Mev electron bombardment in the solid state at bulk temperatures of −30°C and −70°C. The principal product in all cases is a material polymer of higher molecular weight than that of the starting reactant. G (polymer) values range from 0.5 to 0.8 for all except saligenin, which is 2.7. For 2,2′-dihydroxydiphenylmethane the polymer contains from two to three reactant residues. In addition to the polymer, gas, which is about 90% hydrogen, is produced with G values ranging from 0.06 to 0.27. The dimethyl ether of 2,2′-dihydroxydiphenylmethane is exceptional in that more methane is formed than hydrogen. Finally, products representing fragmentation of the original molecule are produced in small yields. The total yield of fragmentation products is of the order of G (volatiles) = 0.2. The formation of products may be visualized as proceeding through an excited reactant molecule which may eliminate hydrogen gas either concertedly or sequentially to give an unstable quinone methide. Hydrogen atoms from stepwise dissociation of the reactant are expected to be captured by a reactant molecule to give a precursor of the stable fragmentation products observed. (auth)

12238 THE LIQUID SCINTILLATION COUNTING OF $C^{14}O_2$ ABSORBED ALKALI-SPOTTED FILTER PAPER. Eugene B. Dowdle and G. D. Sweeney (Univ. of Cape Town, South Africa). S. African J. Lab. Clin. Med., 9: 1-5(Mar. 1963).

In the Bosquet and Christian method (Anal. Chem., 32: 722(1960)) the successful liquid scintillation counting of C^{14} absorbed on filter paper immersed in a phosphor solution is attained. It is proposed that respiratory $C^{14}O_2$ evolved during the course of incubation may be counted more expediently by transferring the alkali-spotted filter paper directly from the Warburg vessel to a vial containing phosphor solution, and counting the filter paper together with the absorbed $C^{14}O_2$ on a liquid scintillation counter. Precautions necessary to obtain valid counting rates using this procedure are evaluated. It was shown that toluene was a more satisfactory solvent than dioxane for the phosphor (2,5-diphenyloxazole and 1,4-bis-2(5-phenyloxazolyl)-benzene) solution. The volume of alkali solution applied to the filter paper should not exceed the capacity of the filter paper to retain the alkali in a discrete spot in the center of the filter paper. It was found that a dropper calibrated to deliver drops of 20 μl is best for this purpose. The quality of the filter paper used (Whatman No. 3 was satisfactory) should not be such that its absorptive capacity is not exceeded by the volume of fluid added. Allowance should be made for the fact that different volumes of phosphor solution in the counting vial affect the counting efficiency. The efficiency with which C^{14} is counted with this technique varies with the nature of the C^{14}-labeled compound on the filter paper, and allowance should be made for this. For example, it was shown that the efficiency with which $C^{14}O_2$ was counted was only 66% of that with which glycine-1-C^{14} was counted. The reason for this lower efficiency with $C^{14}O_2$ is not clear. It was concluded that the counting of respiratory $C^{14}O_2$, by placing the alkali-spotted filter paper from the center well of a Warburg vessel directly in a phosphor solution in a counting vial and counting with a liquid scintillation counter, provides a rapid and reliable method for determining the radioactivity of respiratory CO_2 provided the above-mentioned precautions are taken. (BBB)

12239 HELIUM DIFLUORIDE: POSSIBLE PREPARATIVE TECHNIQUES BASED ON NUCLEAR TRANSMUTATIONS. George C. Pimentel (Univ. of California, Berkeley), Richard D. Spratley, and Alan R. Miller. Science, 143: 674(Feb. 14, 1964).

Difluoride may be prepared by beta decay of tritium, lithium-6 transmutation, or alpha-particle bombardment. In the first method, which may be the most feasible, tritiated potassium bifluoride could be used as a host lattice. The beta-decay recoil energy would not dislodge the daughter helium atom from the host site, thus helium difluoride could perhaps be formed in an ideally shaped lattice site. (auth)

12240 ISOTOPIC MOLECULES: SEPARATION BY RECYCLE GAS CHROMATOGRAPHY. John W. Root, Edward K. C. Lee, and F. S. Rowland (Univ. of Kansas, Lawrence). Science, 143: 676-8(Feb. 14, 1964).

Gas chromatographic columns, greatly extended in length by the use of paired columns in a recycling apparatus, have been used to separate butane ($n\text{-}C_4H_{10}$) from deuterated butane ($n\text{-}C_4D_{10}$) and methane (CH_4) from deuterated methane (CD_4). The separation of monotritiated cyclobutane (C_4H_7T) from cyclobutane (C_4H_8) is nearly complete. This procedure is generally applicable to a wide variety of separations of isotopic molecules. (auth)

12241 PHOTOSCINTILLATIONS IN CRYSTALS ACTIVATED WITH MERCURY-LIKE IONS. T. A. Soovik and E. Kh. Realo. Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR, No. 23, 97-108(1963). (In Russian)

The decay time of photoscintillations (luminescence excited by short (10^{-7} sec) spark-light pulses) of some alkali-halide and phosphate phosphors activated with mercury-like ions were investigated. The decay times of photoscintillations of the phosphors were in good agreement with the idea of the main emission band corresponding to the electronic transition $^3P_1 \rightarrow {}^1S_0$ in free mercury-like ions. The energy of exciting quanta ranging from 4.1 to 5.7 ev, the decay time of photoscintillations in KI−Tl is constant and equal to the mean life of the Tl-center in state ^3P ($\tau = 2.5 \cdot 10^{-7}$ sec, T = 295°K). Comparison of quantum yield spectra of photoscintillations and of stationary luminescence shows that the main component of the luminescence of the Tl-centers excited in the long-wave fundamental absorption band is non-inertial ($\tau < 10^{-8}$ sec). This confirms the exciton character of the absorption band and the exciton mechanism of energy transport to the Tl^+-center. The quantum yield of photoscintillation excited in the long-wave fundamental absorption band is large enough to enable the exciton mechanism of energy transport to account for the mechanism of scintillation caused by the ionizing particles. (auth)

12242 SOME PECULIARITIES OF PHOTOLUMINESCENCE IN NaI−Tl AND NaI−In. R. A. Kink and G. G. Liidja (Liid'ya). Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR, No. 23, 109-36(1963). (In Russian)

Luminescence in NaI−Tl and NaI−In phosphors excited

with ultraviolet radiation was investigated as depending on the excitation wavelength, intensity and time, and temperature, as well as on simultaneous irradiation with red light. Under stationary conditions, saturated quantum yield of luminescence due to activator, both in the exciton band, and when excited with shorter wavelengths corresponding to band-to-band transitions approaches the quantum yield in the activator absorption band when $^1S_0-^3P_1$ transitions are excited. In this respect NaI-phosphors are similar to the other activated iodides (KI–Tl, KI–In, RbI–Tl, CsI–Tl heavily doped). The kinetics of NaI–Tl luminescence is different from that of KI–Tl and RbI–Tl. When excited, luminescence rises in the exciton band slowly, and only 15% of the saturated intensity is built up momentarily (faster than in 10^{-2} sec). The intensity of the instantaneous component depends on the intensity of excitation linearly, that of the inertial component, superlinearly. If NaI–Tl crystal is excited in the long wavelength band tail region of the exciton band where the exciting light penetrates deeper than 1 μ, the kinetics of NaI–Tl nears that of KI–Tl. Fall in temperature also weakens that peculiarity of NaI–Tl and NaI–In phosphors. On excitation at 100°K in the band-to-band region the luminescence build-up remains slow, whereas on exciton-excitation the inertial component is reduced to 40% (NaI–Tl), or disappears altogether (NaI–In). The shape of the excitation spectrum of phosphorescence proves that the exciting light quanta whose energy corresponds to the shoulder in the absorption spectrum of NaI (5.7–5.8 electron volts) create electrons and holes in the crystal. (P.C.H.)

12243 TRAPPING OF ELECTRONS AND HOLES BY LUMINESCENCE CENTERS IN ALKALI HALIDE CRYSTALS ACTIVATED WITH MERCURY-LIKE IONS. G. K. Vale. Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR, No. 23, 137-54(1963). (In Russian)

Trapping of electrons and holes by luminescence centers in alkali halide crystals activated with Pb^{2+} and Sn^{2+} ions was investigated at 295 and 100°K. At 295°K the Pb^{2+} and Sn^{2+} ions serve as efficient trapping centers for the electrons. The spectral characteristics of the electronic activator color centers were investigated by measuring the spectra of the creation of F-centers in x-rayed and bleached crystals, and interpreted as electronic transitions in Pb^+ and Sn^+ ions. In the crystals of NaCl–Sn, KCl–Sn, and KCl–Pb x rayed at 100°K, the number Pb^{2+} and Sn^{2+} centers was found to increase after irradiation in the region of the F-band. This effect is regarded as a manifestation of the trapping of holes by the defects of the type $Sn^{2+}v^+$ and $Pb^{2+}v^+$. (auth)

12244 RECOMBINATION LUMINESCENCE SPECTRA OF KBr CRYSTALS ACTIVATED WITH MERCURY-LIKE IONS. I. V. Yaek and M. F. Okk. Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR, No. 23, 155-69(1963). (In Russian)

Recombination luminescence spectra of x-rayed KBr phosphors were studied. Thermal glow curves and thermoluminescence spectra of Tl^+–In^+-, Ga^+-, Sn^{2+}-, and Pb^{2+}-activated KBr were measured. The thermoluminescence spectra obtained fairly coincide with the activator fluorescence spectra. The applicability limits of the spectral investigation method of thermal glow are discussed. Thermoluminescence characteristics of Sn^{2+}-activated phosphors and those of In- and Ga-activated ones were found to be similar. The similarity is due to the ability of $Sn^{2+}v^+$-centers to capture both electrons and holes (v^+-a cation vacancy). The reasons for the absence of thallium ions emission during low temperature stages of the relaxation process are discussed. (auth)

12245 ON THE EXCITATION OF IMPURITY CENTERS IN ALKALI HALIDE CRYSTALS WITH ELECTRON-HOLE RECOMBINATIONS. I. V. Yaek. Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR, No. 23, 170-5(1963). (In Russian)

It was established that, as a result of recombination processes either $^3P_1$ states of luminescence centers appear, or anions adjacent to Tl^+ are excited. The spectra of optical flash (stimulated in F-band) and thermal glow of KI–Tl x rayed at 100°K were compared with its spectra of fluorescence excited in different absorption bands. Analogous data relative to KBr–Pb phosphors led to the conclusion that Pb^{2+} centers assume the $^1P_1$ state as a result of the recombination processes. (auth)

12246 ON THE LUMINESCENCE MECHANISM OF KCl–Ag. G. K. Zolotarev. Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR, No. 23, 175-88(1963). (In Russian)

Optical absorption spectra and recombination luminescence spectra (spectra of optical flash stimulated in the E-band, and spectra of thermoluminescence) for KCl–Ag phosphor excited with x rays both at liquid oxygen and room temperatures were measured. Relations between the E-centers and the principal luminescence centers were studied. It is shown that the phosphorescence of silver ions results from the recombination of the electrons with localized holes, appears to be electronic recombination luminescence. Possible nature of green emission is discussed. (auth)

12247 STUDIES ON X-AGENT. XVI. THE NATURE OF TRANSMITTANCE CHANGE INDUCED BY X-AGENT IN FROSTED GLASS SURFACE. Hideo Moriyama (Shonan Hygiene Inst., Kamakura, Japan). Yokahama Med. Bull., 13: 127-47(Apr. 1962).

It is proposed that colloidal solutions or frosted glass surfaces are changed by X-agent; they alter the light passing through them, the light thereby becoming capable of affecting the sensitivity of the cell. This is considered to be the cause of the apparent change of the transmittance of the glass surface. The altered light appears to be scattered light, which when produced from colloidal matter acted on by X-agent, can influence the sensitivity of the photoelectric cell. It is shown that γ rays are also scattered in matter, their properties thereby being altered as in scattering of visible rays, and it is suggested that photons, in general, including γ rays and thermal radiations, may undergo an analogous alteration when they pass through a substance that is affected by X-agent. It is postulated that the altered photon that is scattered by matter, which is in a special state, is the X-agent. All the phenomena so far observed relating to this agent are interpreted on this assumption. (TCO)

12248 THE GAMMA RADIOLYSIS OF AMMONIA AND THE METHYLAMINES IN THE GAS PHASE. Robert Carl Schiek. Thesis, Durham, N. H., Univ. of New Hampshire, 1963. 80p.

Radiolysis of ammonia by Co-60 γ rays results in H and N. The yield of H was observed over a 7-fold change in total dose. The presence of an inert gas shows charge transfer. The radiolysis of methylamine results in H, methane, ammonia, and dimethylamine as products. H, methane, and ammonia increase in yield with irradiation time, while dimethylamine decreases. H and methane are pressure independent products. Ammonia and dimethylamine appear to be pressure dependent. Scavenger study with I indicates that ammonia and dimethylamine are partially produced by radical reactions. Charge transfer was

again demonstrated with inert gases. H and methane were the only identified products from the radiolysis of dimethylamine. Both increase with irradiation time. The addition of He resulted in formation of trimethylamine, and an increase in the yield of H and methane. H, methane, dimethylethylamine, ammonia, and 2 unidentified compounds were formed from the γ radiolysis of trimethylamine. The presence of He resulted in an increase in the yield of H and methane. One of the unidentified compounds decreased in yield with He present. Addition of nitrogen(II) oxide to the methylamines at liquid–N temperature resulted in formation of white compounds. These compounds were unstable when exposed to the atmosphere. The dimethylamine compound has not been previously reported. (Dissertation Abst.)

12249 THE GAMMA RADIOLYSIS OF AQUEOUS AND ALCOHOLIC SOLUTIONS OF ORANGE IV. Allen Albert Denio. Thesis, Durham, N. H., Univ. of New Hampshire, 1963. 103p.

The decolorization of deaerated aqueous solutions of Orange IV is the result of H atom and hydroxyl radical attacks. The H atoms are believed to add to the azo or amine N atoms and the hydroxyl radicals probably add to the aromatic C atoms. The decolorization when O is present initially is attributed to hydroxyl and hydroperoxyl radical additions until the O is consumed. The yields of the decolorization reactions in water are very low compared to the yields of H atoms and hydroxyl radicals formed. It was estimated that 10 to 14 radicals are required for each dye molecule decolorized. The dye molecule may serve as a site for the recombination of a H atom and a hydroxyl radical. Some further oxidation appears after irradiation and is attributed to the hydrogen peroxide formed with a yield of G = 0.67. The decolorization of deaerated methanolic solutions of Orange IV results from its reduction to the hydrazo derivatives by the addition of H atoms, methylol, methyl, and hydroxyl radicals. The decolorization reaction in methanol containing O is inhibited until the O is consumed. Both reactions are discussed. The monoazo dye Orange I behaves in a similar manner to Orange IV when deaerated methanolic solutions are irradiated. The radical additions to the azo linkage apparently yield the derivatives of sodium sulfanilate and 4-amino-1-naphthol. The results obtained in ethanolic solutions are apparently analogous to those in methanolic solutions. The efficiency of the decolorization process is again high and indicates essentially 100% addition of the radicals to the azo linkage. The use of ionizing radiation in an organic synthesis is illustrated by this work. The principal limitation to this method is the mixture of products obtained from the random addition of the free radicals formed from the solvent. The process is easily performed and proceeds with a very high efficiency. (M.P.G.)

12250 CROSSLINKED POLYMERIC COMPOSITIONS. Trevor Thomas Greenwood, Solomon Harris Pinner, Robert Roy Smith, and Vernon Wycherley (to B. X. Plastics Ltd.). British Patent 948,762. Feb. 5, 1964. Filed June 22, 1959.

A method for the manufacture of infusible, cross-linked polymeric compositions is described wherein a blend of a polymer, which normally suffers radiation degradation, and a polymerizable compound containing at least two ethylenically unsaturated double bonds is exposed to an electron beam for a dose greater than 2 megarads. The blend may be irradiated both before and after its fabrication into a desired form. The polymer may be cellulose acetate, polymethyl methacrylate, cellulose acetobutyrate, or polyisobutylene, and the polymerizable compound is a poly allyl ester such as diallyl sebacate, triallyl cyanurate, or triallyl citrate. (R.E.U.)

12251 IRRADIATION OF MATERIALS. William Henry Thomas Davison (to T. I. (Group Services) Ltd.). British Patent 949,191. Feb. 12, 1964. Filed Oct. 15, 1960.

A process is described for curing or hardening an organic synthetic resin coating on one face of an impervious sheet by electron-induced cross-linking of the resin by an unsaturated monomer. The electrons are of 50 to 250 kev. The monomer is vinyl carbazole, diallylphthalate, or styrene, and the polyester resin is in liquid form prior to irradiation. Examples are given. (R.E.U.)

12252 GAMMA RADIATION NITRATION OF ALKANES. Lyle F. Albright and Roberto Lee (to Purdue Research Foundation). U. S. Patent 3,120,478. Feb. 4, 1964. Filed Oct. 6, 1960.

The production of nitroalkanes by vapor-phase nitration of saturated aliphatic hydrocarbons of the paraffin series at 370 to 460°C using nitric acid and oxides of nitrogen in the presence of oxygen and gamma radiation is described. Propane is contacted with nitric acid and nonexplosive concentrations of oxygen at 370 to 460°C in the presence of Co^{60} gamma radiation of 200,000 r/hr. (R.E.U.)

Separation Processes and Procedures

12253 (BM-RI-6381) METATHESIS OF BASTNASITE AND SOLVENT EXTRACTION OF CERIUM. D. J. Bauer and V. E. Shaw (Bureau of Mines. Reno Metallurgy Research Center, Nev.). June 1963. 18p.

Bastnasite concentrate was processed to recover total rare-earth content and obtain high-purity ceric nitrate. Reaction of the concentrate with 45 percent caustic soda for 1 hour at 180°C in stainless steel vessels resulted in 99-percent conversion to rare-earth hydroxides. A drying step followed by solution in nitric acid produced a tetravalent cerium fraction amenable to extraction with TBP. Single-stage separatory funnel experiments resulted in 90-percent recovery of ceric nitrate at a purity of 99.9 percent. Fractional extraction in pressure-bubbler columns resulted in 98.5-percent recovery of 99.5-percent-pure ceric nitrate. (auth)

12254 (HW-68655) AMMONIUM BIFLUORIDE FUSION OF IGNITED PLUTONIUM DIOXIDE. H. W. Crocker (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 24, 1961. Contract W-31-109-eng-52. 5p.

An ammonium bifluoride fusion process for plutonium recovery from ignited (1000°C) plutonium dioxide was developed. The fusion mass can be readily taken up in aluminum nitrate solution. Results of these studies show an average plutonium recovery of 95 percent in the final aqueous solution. The fusion method has a short time cycle (three hours), utilizes small aqueous solution volumes (one liter ANN per 35 grams of original PuO_2), and the plutonium product solution in aluminum nitrate is suitable for direct blending into the existing Recuplex system. In addition, the only off-gas handling equipment required is a small water scrubber. It is recommended that the method be given further testing in a plant-scale production test. The method also has application for plutonium recovery from incinerator ash, and for plutonium metal or skulls which have previously been converted to plu-

tonium dioxide by steam oxidation or controlled burning. Direct fusion of metal or skulls may be possible, but the uncertain reactivity of these materials may make this approach undesirable. (auth)

12255 (IA-864) ION EXCHANGE AND SOLVENT EXTRACTION STUDIES WITH MOLTEN NITRATES. Y. Marcus, M. Liquornik, L. F. Friedman, and M. Zangen (Israel. Atomic Energy Commission. Soreq Research Establishment, Nahal Soreq). Nov. 1963. 16p.

Cation exchange isotherms show that the Linde zeolite 4A favors thallium (I) and silver over sodium, when exchange occurs from molten nitrates. The zeolite occludes 9 to 10 molecules of $NaNO_3$ and $AgNO_3$ per unit cell, but no $TlNO_3$. The distribution of mercury chloride tracer between molten polyphenyl and K : Li nitrate eutectics was studied as a function of chloride concentration and temperature. Anionic mercury chloride complexes were found in the salt melt. (auth)

12256 (IDO-14621) CHEMICAL PROCESSING TECHNOLOGY QUARTERLY PROGRESS REPORT, APRIL–JUNE 1963. J. R. Bower, ed. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Jan. 15, 1964. Contract AT(10-1)-205. 42p.

ICPP processing operations included dissolution and first cycle extraction of all available ETR, MTR, LITR, WTR, and GETR fuel elements; rates averaged 90% of capacity, and decontamination factors were normal. Processing capacity of the plant for Brookhaven Graphite Research Reactor (BGRR) fuel was limited due to the element shape and low uranium loading. A facility capable of flattening these elements to ⅓ of the original bulk, without an excessive release of fission products to the basin, was designed and tested successfully. Favorable laboratory results were obtained in processing OMRE fuel without prior removal of the coating of degraded organic coolant. Zirconium fuel processing studies demonstrated a significantly higher dissolution rate for the uranium of irradiated PWR-type fuel than for the cladding, indicating that accumulation of undissolved uranium in the dissolver would be unlikely during plant operation. Boiling 0.1 M chromic acid was effective in removing solids containing uranium fluoride generated adjacent to reagent nozzles in a Monel zirconium-process dissolver. Dibutyl phosphate, a TBP degradation product encountered in uranium extraction processes, was removed from first cycle product by adsorption on hydrated zirconia under a variety of laboratory and pilot plant conditions; the loaded zirconia bed was regenerated with sodium hydroxide without adverse effects on continued use. A dibutyl phosphate complex, $[UO_2(NO_3)(DBP)\cdot TBP]_x$, indicated by correlation of previously published data with newer ICPP process data, offers the possibility of describing the distribution of uranium and DBP species during the back extraction operation. Electrolytic dissolver anode current densities of 3.2 amps/cm^2 were achieved in a pilot unit utilizing a dissolver solution of 6.5M nitric acid containing less than 20 g of dissolved stainless steel per liter; a current density of 2.1 amps/cm^2 was achieved in solutions containing 50 to 70 g/l of dissolved stainless steel. The main limitation in achieving higher current densities was believed to be anode polarization and the accompanying gassing; temperature and solution gap were important, principally as they influenced the gas evolution and confinement. Waste treatment studies, directed at adsorption of radioactive cerium and chromium from MTR pond wastes by natural earth materials, indicated that the presence of EDTA had little influence on the distribution coefficient of 1000 when the elements were present as cations. With chromium as a dichromate rather than as a cation, the nature of the adsorbent became significant; lignite maintained its efficiency, due to its combination of anion and cation exchange properties, while clay and clinoptilolite lost efficiency due to the lack of anion exchange properties. Extensive improvements in the aluminum nitrate freeze-melt apparatus for separation of fission products from first cycle aluminum-process raffinates are discussed. The ICPP waste calcining facility is being readied for production operation with ICPP stored wastes. Results of laboratory and pilot plant studies on mercury retention, calcine particle growth, fines generation, and possible incorporation of calcine in solid matrices are summarized. Plant improvement studies reported include initial hot runs on a steam stripper for removal of plutonium from TBP-Amsco; alpha activity was reduced from 10^4 counts/minute to background. Cadmium-poisoned fuel storage racks were designed to give more efficient utilization of basin storage space through closer spacing of the stored elements. (auth)

12257 (NP-13620) REMOVAL OF RADIOACTIVE MATERIAL FROM MILK BY ELECTRODIALYSIS. Final Report. Edgardo J. Parsi and William B. Iaconelli (Ionics, Inc., Cambridge, Mass.). Feb. 7, 1964. Contract OCD-OS-62-206. 159p.

The removal of Sr^{85}, Ba^{140}, Cs^{137}, La^{140}, Ce^{139}, and I^{131} from milk by electrodialysis was investigated. Existing data on milk decontamination are summarized and methods of decontamination are evaluated. An investigation was made of an electrodialysis process in which radioactive ions, along with other ions normally present in milk, are removed electrically through an ion-transfer membrane into a waste solution. These ions are replaced simultaneously through another ion-transfer membrane from an aqueous solution of salts. Important variables include current density, milk pH, temperature, composition and concentration of the salt solution used for ion replenishment, and type of membrane. Over 90% of Sr was removed when the pH of the milk was adjusted to 5.1 to 5.3, and about 80% of Ba and over 99% Cs were removed. In separate experiments 70 to 90% removal of I was obtained. The total investment cost for a 5000 gal/hr plant was estimated to be about $830,000, with the operating cost about 0.5 cents/qt of milk. It is recommended that a pilot plant program be undertaken to test the process in a large scale and to develop information for the design of a full-scale plant. (C.H.)

12258 (PAN-453/XIX) ION EXCHANGE COLLECTORS—A NEW TYPE OF ION EXCHANGER BED. A. Kortyrko (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Aug. 1963. 24p.

Method of producing the ion exchange collectors, their characteristics, and possibility of use is discussed. The results of experiments on $Sr^{90} + Y^{90}$ and Cs^{137} ion exchange in collector batch systems at different conditions are given after theoretical introduction. It is evident, from these data, that the collectors represent a convenient tool in ion exchanger investigations. It was found out that inhomogeneous magnetic fields exert a strong influence on course of sorption processes. First experimental results concerning this problem are given. (auth)

12259 (UCRL-10971) A SOLVENT EXTRACTION STUDY OF PROTON SOLVATION (thesis). Teresa Jean Conocchioli (California. Univ., Berkeley. Lawrence

Radiation Lab.). Sept. 4, 1963. Contract W-7405-eng-48. 76p.

The extraction of $HClO_4$ and HNO_3 into dilute solutions of tri-n-octyl phosphine oxide (TOPO) in carbon tetrachloride and nitrobenzene is studied, and the nature of the extracting species is determined. In the extraction of dilute $HClO_4$ (≤0.2 M) into dilute TOPO (≤0.1 M) in CCl_4, the extracting species are TOPO · H_2O and H_3O^+ · 3 TOPO··· ClO_4^-. The predominant species in the extraction of HNO_3 (≤0.3 M) is anhydrous and is TOPO · HNO_3. In the extraction of both dilute $HClO_4$ and HNO_3 into TOPO in nitrobenzene, the extracting species is H_3O^+ · 3 TOPO · $yH_2O + X^-$, in which y is probably 0 but may be as large as 3, and in which X^- is the anion. The results of the extraction are interpreted on the basis of the evaluation of the relative basicities of all components in each system and of the dielectric constant of the inert diluent. (auth)

12260 (USNRDL-TR-704) CARRIER-FREE SEPARATION OF THE INDIVIDUAL RARE EARTH RADIONUCLIDES FROM FISSION PRODUCT MIXTURES. L. Wish and S. C. Foti (Naval Radiological Defense Lab., San Francisco). Dec. 5, 1963. 18p. (AD-429298)

A procedure based on solvent extraction with diethylhexylphosphoric acid was tested for the quantitative carrier-free separation of yttrium and the rare earth group elements from other fission products. This procedure is simpler and more rapid than the previously used cation exchange resin separations of rare earths from alkali metals and alkaline earths. Subsequent quantitative carrier-free isolation of individual rare earth fission products was accomplished by their elution from cation exchange resin with alpha-hydroxyisobutyric acid at room temperature. (auth)

12261 CHEAPER HEAVY WATER A BONUS FOR AECL. Can. Chem. Process., 46: 76-8(June 1962).

Improvements in the GS process for producing heavy water that could bring the cost down to $14.50/ton are discussed. General economic aspects of heavy water production are outlined. The GS process is described. (M.C.G.)

12262 THE SYNERGIC EFFECT OF TRI-n-BUTYL PHOSPHATE IN THE EXTRACTION OF URANIUM(VI) FROM SULPHURIC ACID SOLUTIONS BY DI-(2-ETHYLHEXYL)-PHOSPHORIC ACID. Taichi Sato (Government Chemical Industrial Research Inst., Tokyo). J. Inorg. Nucl. Chem., 26: 311-19(Feb. 1964).

The partition of uranium (VI) between sulfuric acid solutions and solutions containing combinations of di-(2-ethylhexyl)-phosphoric acid (DEHPA) and tri-n-butyl phosphate (TBP) in kerosene was investigated at varying concentrations of sulfuric acid, solvent, and uranium and at different temperatures. The change in the acidity of the organic solutions was also examined. An infrared spectral study was made of the organic phases obtained. The mechanism on the synergic effect of TBP in the extraction of uranium (VI) from sulfuric acid solutions by DEHPA is discussed on the basis of the results obtained. (auth)

12263 HIGH TEMPERATURE ORGANIC EXTRACTION OF URANIUM, PLUTONIUM AND AMERICIUM FUSED CHLORIDES. Z. Borkowska, M. Mielcarski, and M. Taube (Inst. of Nuclear Research, Warsaw). J. Inorg. Nucl. Chem., 26: 359-71(Feb. 1964).

The distribution of U, Pu, and Am between a KCl–CuCl eutectic melt and an organic phase (TBP, TOA, HDBP diluted by diphenyl) was investigated at 180°C. Distribution ratios were determined for U(IV), U(III), Pu(IV), Pu(III), and Am(III), and for the components of the salt phase Cu(I), K(I), and Cl. The distribution ratios obtained in order of ascending magnitude, were $D_K^{TOA} \ll D_{Cu}^{TOA} < D_{Pu(III)}^{TOA} < D_{Am(III)}^{TOA} < D_{U(III)}^{TOA} \ll D_{U(IV)}^{TOA}$ where $D_{U(IV)}^{TOA} = \sim 50\ D_K^{TBP} < D_{Cu}^{TBP} < D_{Am(III)}^{TBP} < D_{U(III)}^{TBP} < D_{U(IV)}^{TBP}$. (auth)

12264 SEPARATION OF MOLYBDENUM FROM TUNGSTEN BY EXTRACTION METHODS. H. Grubitsch and T. Heggebo (Technische Hochschule, Graz.). Monatsh. Chem., 93: 274-81(1962). (In German)

Molybdate and tungstate solutions containing various concentrations of acids (HCl, HNO_3, $HClO_4$) were extracted with ether, ethyl acetate, diisopropyl ether, diisopropyl ketone, and 1:1 acetylacetone-chloroform. Data for Mo extraction are presented graphically and distribution coefficients are calculated. Tungsten complexed with citric acid was not extracted into these solvents under similar conditions, except for traces extracted into ether from 3N and stronger HNO_3. The influence of W and citric acid on the extraction of Mo by 1:1 acetylacetone-chloroform and the influence of citric acid at different HCl concentrations are tabulated. When 10–80 mg Mo and 10–80 mg W in 20 ml 2N containing 2 g citric acid is extracted with 20 ml 1:1 acetylacetone-chloroform, 99.8% of the Mo is found to be in the organic phase. (BBB)

12265 THORIUM CONTENT OF, AND ITS SEPARATION FROM, COMMERCIALLY AVAILABLE PURE LUTETIUM OXIDE. H. Titze (Osterreichische Studiengesellschaft fur Atomenergie GmbH, Vienna). Nature, 201: 66 (Jan. 4, 1964).

Methods for separating thorium and radium from commercially available lutetium oxide are described. Thorium was adsorbed on a cation exchange resin after dissolution of the lutetium oxide in HCl. The lutetium was eluted with HCl. The radium was precipitated with barium sulfate after barium chloride and sulfuric acid were added to the solution. The lutetium was precipitated with oxalic acid and converted to oxide in a furnace at 800°C. (M.C.G.)

12266 SOLVENT EXTRACTION OF URANIUM USING ALKYLAMINES. APPLICATION OF THE CONVERSION PROCESS. Takeo Murase (Atomic Fuel Corp., Tokyo). Nippon Genshiryoku Gakkaishi, 5: 971-9(Dec. 1963).

A new conversion refining process using high molecular weight alkylamines was developed in order to obtain directly highly purified UF_4 or UO_3 from ore leaching solution without the precipitation process of yellow cake. Suitable conditions for the extraction, conversion, and stripping process are described, and also the flow diagram of the new refining process is given. (auth)

12267 EXTRACTION OF URANIUM FROM AQUEOUS NITRIC ACID SOLUTION BY SOME TWENTY ORGANOPHOSPHORUS COMPOUNDS. Mitsuru Asano and Tomota Nishi (Kyoto Univ.). Tech. Rept. Eng. Res. Inst., Kyoto Univ., 13: 107-16(Dec. 1963).

The extraction ability of ten trialkyl phosphates, five dialkyl hydrogen phosphonates, three dialkyl alkyl phosphonates, three alkyl dialkyl phosphinates, and two trialkyl phosphine oxides for uranyl nitrate is reported. Methods of preparation and some of their basic properties are also reported. The extraction ability of organophosphorus compounds with only n-butyl groups increases in the following sequence: dialkyl hydrogen phosphonate < trialkyl phosphate < dialkyl alkyl phosphonate < alkyl dialkyl phosphinate < trialkyl phosphine oxide. These effects are attributable to the electronic configuration of organophosphorus compounds. As to the effect of size of alkyl groups,

among trialkyl phosphates and dialkyl hydrogen phosphonates the extraction ability increases as the number of carbon atoms in alkyl groups becomes larger and by branching of carbon chain, especially at α position carbon in them. (auth)

12268 THERMODYNAMICS FOR THE SOLVENT EXTRACTION OF SEVERAL URANYL COMPOUNDS BY DI 2-ETHYL-HEXYL PHOSPHORIC ACID (D2EHPA). Mitsuru Asano, Yasuharu Okajima, and Tomota Nishi (Kyoto Univ.). Tech. Rept. Eng. Res. Inst., Kyoto Univ., 13: 117-26(Dec. 1963).

The extraction reaction of uranyl compounds by di 2-ethyl-hexyl phosphoric acid is shown to be $UO_{2aq}^{2+} + 2(HX)_{2org} \rightleftharpoons UO_2X_2(HX)_{2org} + 2H_{aq}^{+}$ from the dependency of the distribution of metals on the various reagent concentrations. It was found that di 2-ethyl-hexyl phosphoric acid was a dimer in the organic phase by the determination of its molecular weight. The thermodynamic quantities were also calculated. There were substantial alternations in the values of ΔF, ΔH, and ΔS for different kinds of diluents, especially for oxygen containing diluents. While ΔF and ΔH are affected by the species of anions in the aqueous phase, ΔS is little influenced by them. (auth)

12269 IMPROVEMENTS IN OR RELATING TO THE TREATMENT OF BERYL ORES. Raymond Derry and Ronald Keith Bayliss (to United Kingdom Atomic Energy Authority). British Patent 948,371. Feb. 5, 1964. Filed Oct. 13, 1961.

An improved method is given for treating beryl ores to facilitate the recovery of Be therefrom. The method comprises feeding the ores in the form of a powder into a gas stream at a high temperature (>1700°C) so that the powder particles are melted and solidified to form spherical glassy particles. The spherical particles may then be treated with acid to extract the Be. The gas stream may be heated by an oxy-acetylene flame or a plasma torch. The method is applicable to high- and low-grade ores, and several examples of the method are given. (D.L.C.)

12270 IMPROVEMENTS IN OR RELATING TO THE RECOVERY OF CAESIUM. John Hickman Moss (to United Kingdom Atomic Energy Authority). British Patent 949,483. Feb. 12, 1964. Filed May 25, 1961.

A method is given for separating cesium from an aqueous solution, especially Cs^{137} from a solution of fission products. The method comprises contacting the solution with a water-immiscible solvent for cesium polybromides in the presence of a bromide salt and bromine, whereby the cesium forms polybromides and is extracted, and removing the extracted cesium from the solvent by steam stripping of the free bromine. The solvent preferably is nitrobenzene with a heavy inert diluent (CBr_4 or $C_2H_2Br_4$) added to increase its density. The method is highly specific to cesium; at 90% extraction, only 10% of the rubidium is extracted and less than 1% of any of the other metals. A flow sheet is included. (D.L.C.)

12271 IMPROVEMENTS IN OR RELATING TO ION EXCHANGE RESIN REGENERATION. Roger Platzer and Pierre Chagnon (to Commissariat a l'Energie Atomique). British Patent 949,832. Feb. 19, 1964. Priority date June 16, 1959, France.

A process was developed for the continuous electrolytic regeneration of ion exchange resins. The resin is continuously circulated in a regeneration solution between electrodes so that the resin moves parallel to at least one of the electrodes and as a thin layer in the immediate vicinity of the surface of the electrode. By combining this process of fixation, by an ion exchange resin, of one of several ions of a solution to be purified, a purification installation adapted to operate continuously in an automatic manner and to be remotely controlled was obtained. (M.C.G.)

12272 A METHOD OF TESTING AND APPARATUS APPLICABLE TO THE CONTROL OF THE MANUFACTURE OF URANIUM. Adrian Walton Fenton (to United Kingdom Atomic Energy Authority). British Patent 950,198. Feb. 19, 1964. Filed July 8, 1960.

A method of testing was developed that was applicable to the control of the manufacture of uranium. The electric conductivity and specific gravity of an acid solution of a uranium salt are measured and these measurements correlated to give the acidity and/or uranium concentration of the solution. (M.C.G.)

12273 METHOD FOR THE PRODUCTION OF URANIUM COMPOSITIONS. Augustin Driessen and Henri de Saint-Chamant (to Centre d'Etudes et de Recherches des Phosphates Mineraux Cerphos). German Patent 1,157,591. Nov. 21, 1963. Priority date July 12, 1957, France.

Uranium compositions are obtained from slags derived by the thermal reduction of basic slags in the presence of silicic acid. The method comprises the steps of adding 5 to 6 n- nitric acid to a watery suspension of the slag, of heating this mixture, which has a pH between 2 and 3, to temperatures between 70 and 80°C for about an hour, of separating the insoluble ingredients by filtration, and of obtaining the uranium compositions from the remains by ways known in the art. (Gmelin Inst)

12274 DEVICE FOR THE CONTINUOUS REMOVAL OF CANS OF NUCLEAR FUEL ELEMENTS. Georges Bonnet (to Commissariat à l'Énergie Atomique). German Patent 1,158,640. Dec. 5, 1963. Priority date Sept. 19, 1960, France.

The device described is for the removal of cans of fuel elements which consist of a fuel rod floatingly arranged within the can. A notable feature of the device is that the fuel rod and can are separately recovered in an entirely automatic way. The device comprises two grooved rollers by the action of which the can is folded up in axial direction, and a cutting device for shearing the can along the fold. (Gmelin Inst)

12275 METHOD FOR THE SEPARATION OF URANIUM OXIDES FROM THE OXIDES OF THORIUM AND OR PLUTONIUM. Ward Lewis Lyon and Phillip Court (to U. S. Atomic Energy Commission). German Patent 1,159,920. Dec. 27, 1963. Priority date June 28, 1960, United States.

The method comprises the steps of suspending the oxides in molten-salts, of transforming the uranium oxides selectively by the action of a chlorinating agent, and of filtering the melt. It is proposed to use a NaCl–KCl eutectic as molten-salts. (Gmelin Inst)

12276 METHOD FOR THE REMOVAL OF ZIRCONIUM AND FLUORIDE IONS FROM A SOLUTION CONTAINING THESE IONS BESIDES IONS OF URANIUM. Billie Joseph Newby (to U. S. Atomic Energy Commission). German Patent 1,159,921. Dec. 27, 1963. Priority date Sept. 25, 1961, United States.

The method described uses sodium formate for precipitating selectively the zirconium and fluoride ions. The sodium formate may be added in an amount of 2 mols to one mole zirconium or as a watery solution e.g. in 3- to 8-molar concentration. (Gmelin Inst)

12277 FRACTIONATING COLUMN PRODUCT COLLECTOR CONTROL. Gordon Donald Paxson, Jr. (to U. S.

Atomic Energy Commission). U. S. Patent 3,124,172. Mar. 10, 1964.

Means for detecting minute fluid products from a chemical separation column and for advancing a collector tube rack in order to automatically separate and collect successive fractionated products are described. A charge is imposed on the forming drops at the column orifice to create an electric field as the drop falls in the vicinity of a sensing plate. The field is detected by an electrometer tube coupled to the plate causing an output signal to actuate rotation of a collector turntable rack, thereby positioning new collectors under the orifice. The invention provides reliable automatic collection independent of drop size, rate of fall, or chemical composition. (AEC)

12278 THE RECOVERY OF URANIUM FROM GAS MIXTURE. S. H. Jury (to U. S. Atomic Energy Commission). U. S. Patent 3,125,409. Mar. 17, 1964.

A method of separating uranium from a mixture of uranium hexafluoride and other gases is described that comprises bringing the mixture into contact with anhydrous calcium sulfate to preferentially absorb the uranium hexafluoride on the sulfate. The calcium sulfate is then leached with a selective solvent for the adsorbed uranium. (AEC)

12279 PLUTONIUM RECOVERY FROM NEUTRON-BOMBARDED URANIUM FUEL. Raymond H. Moore (to U. S. Atomic Energy Commission). U. S. Patent 3,126,251. Mar. 24, 1964.

A process of recovering plutonium from fuel by dissolution in molten $KAlCl_4$ double salt is described. Molten lithium chloride plus stannous chloride is added to reduce plutonium tetrachloride to the trichloride, which is dissolved in a lithium chloride phase while the uranium, as the tetrachloride, is dissolved in a double-salt phase. Separation of the two phases is discussed. (AEC)

ENGINEERING

General

12280 (ASD-TDR-62-475) RESPONSE OF MISSILE STRUCTURES TO IMPULSE LOADING. T. Wah, L. U. Rastrelli, N. L. Basedekas, and R. C. DeHart (Southwest Research Inst., San Antonio). Mar. 1963. Contract AF33(616)-7956. 102p. (AD-403702)

Procedures for analytically predicting the response of missile bodies to blast loadings are presented. The investigation involves the behavior of cylindrical shells (with various end-closures) and circular, flat plates. The numerical results obtained from the analytical methods compare favorably with the experimental data acquired during the study. (auth)

12281 (BNL-823) NUCLEAR ENGINEERING DEPARTMENT PROGRESS REPORT, MAY 1–AUGUST 31, 1963. (Brookhaven National Lab., Upton, N. Y.). Contract AT-30-2-GEN-16. 109p.

Research and development progress is reported on reactor physics, chemistry and chemical engineering, radiation, hot laboratories, metallurgy, and engineering. Separate abstracts were prepared for each of the 6 topics. (M.C.G.)

For abstracts of individual items see: 11958, 12139, 12282, 12521, 12627, and 13233.

12282 (BNL-823(p.94-6)) ENGINEERING DIVISION. T. V. Sheehan (Brookhaven National Lab., Upton, N. Y.).

On the HFBR project, construction of the biological shield has begun. The cooling tower is 95% complete. Contracts were let for the shutters and associated equipment. The design of the fuel handling training facility was started. The test section for the NaK heat transfer loop is under construction. Most of the major equipment items for the boiling K heat transfer loop were installed in the structure. The contract for the control panel was let. The out-of-pile assembly for the chemonuclear loop is under construction. The natural circulation boiling Na loop is in operation. Fabrication of the pumped boiling Na loop was begun. Construction work on the UO_2-ThO_2 lattice experiment is continuing. A shielded carrier was installed at the BGRR. A portable whole-body counting room was designed for the Medical Department. The conveyor was installed in the High Intensity Radiation Development Laboratory and acceptance tests are being run. A Mark III irradiator was completed. A Mark I irradiator was modified and returned to MIT. The Co sources for the Marine Products Development Irradiator were fabricated and sent to Savannah River for testing and activation. The SBR in-pile capsule experiment was built. An alloy steel water test facility is being built for the Settled Bed Reactor program. Test equipment for the Missile Propulsion Study is being erected. A wood impregnation unit was constructed. (auth)

12283 (HW-80750) METHOD OF CUTTING GLOVE PORTHOLES IN SAFETY PLATE AND LEADED GLASS. S. B. Bates (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 6, 1958. Contract AT(45-1)-1350. 3p.

A method was devised for cutting circular glove portholes in safety plate glass used in hoods. An adjustable arbor attachment was made for the saw. The method comprises cutting a center rectangle in the glass, cutting through the rectangle to the edge of the desired circle, immersing the glass in a hot water tank to soften the glass, and removing the last pieces with glass pliers. (D.L.C.)

12284 (NASA-TN-D-1185) SOME THEORETICAL BASES FOR SELECTION OF MOLECULAR ION PROPELLANTS AND A SURVEY OF MOLECULAR PLASMA COLLISION PROCESSES. John V. Dugan, Jr. (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Feb. 1964. 42p.

The arrangement of electronic and vibrational energy states in diatomic and polyatomic molecules is described as a background for discussing dissociation by impact. The behavior of polyatomic systems under electron impact in the bombardment thrustor is explained in terms of the chemical-bonding characteristics of various classes of molecules. Fragmentation is a consequence of electron-molecule collisions and is discussed with methods for calculating ionization cross sections. Secondary discharge processes affect the composition of the ion beam; their relative rates are estimated. Approaches to guiding selection of suitable molecular propellants are outlined. A useful quantum-mechanical method for predicting stability of presently unavailable compounds is explained, and fundamental experiments are suggested. 42 references. (auth)

12285 AUTOMATIC AND REMOTE CONTROL. Proceedings of the First International Congress of the International Federation of Automatic Control (I.F.A.C.), Moscow, 1960. Volumes I, II, III, and IV. London, Butterworths, 1961. 2188p. $165.00 complete or $44.00 per Vol.

Two hundred and eighty-five papers presented at the First International Congress of the International Federation of Automatic Control are given. Topics covered include: theory of continuous linear systems, theory of continuous non-linear systems, theory of discrete systems, theory of optimal systems, theory of self-adjusting systems, statistical methods of investigation, theory of structure and signal composition, special mathematical problems, simulation and experimental methods, terminology and education, electric and magnetic components, electric simulation and computing components and governors, components and systems for remote and supervisory control, pneumatic components and computing devices, automatic control instruments and devices, automation in metalworking, automation of electrical power systems, automatic electrical drives and machines, automation in transport, automation of industrial processes, automation in chemical and oil industries, automatic control of thermal and nuclear power, and automation of metallurgical processes. Separate abstracts were prepared for 8 papers. (M.C.G.)

For abstracts of individual papers see: 12515, 12516, 13200, 13201, 13202, 13305, 13324, and 13342.

Applications of Nuclear Explosions

12286 (UCRL-7632) SYMPOSIUM ON NUCLEAR EXCAVATION. ABRIDGMENTS. (California. Univ., Liver-

more. Lawrence Radiation Lab.). Jan. 1964. Contract W-7405-eng-48. 26p.

Abridgments are presented of five papers which were presented at the 43rd Annual Meeting of the Highway Research Board, Washington, D. C., on Jan. 13 to 17, 1964. Two of the papers deal with general aspects of nuclear excavation, while the other three are concerned with Carryall Project. Separate abstracts were prepared for all five abridgments. (D.L.C.)

For abstracts of individual items see: 12287, 12288, 12289, 12290, and 12291.

12287 (UCRL-7632(p.1-5)) NUCLEAR EXCAVATION TECHNOLOGY. M. D. Nordyke (California. Univ., Livermore. Lawrence Radiation Lab.). (CONF-378-1)

From 43rd Annual Meeting, Highway Research Board, Washington, D. C., Jan. 1964.

A brief discussion is given of the present state of nuclear excavation technology and of cratering concepts. The safety hazards of nuclear excavation (fallout, air blast, and ground shock) are also discussed. (D.L.C.)

12288 (UCRL-7632(p.6-10)) ENGINEERING PROPERTIES AND APPLICATIONS OF NUCLEAR EXCAVATIONS. Louis J. Circeo, Jr. (California. Univ., Livermore. Lawrence Radiation Lab.). (CONF-378-2)

From 43rd Annual Meeting, Highway Research Board, Washington, D. C., Jan. 1964.

A discussion is given of the effects of the properties of the material in and around the excavation on the nuclear excavation techniques used. The different zones of the excavation (throwout, fallback, true and apparent crater, etc.) are described. Potential applications in highway engineering and other fields are outlined, and Russian experience with chemical explosions is described. (D.L.C.)

12289 (UCRL-7632(p.11-16)) PRELIMINARY DESIGN STUDIES IN A NUCLEAR EXCAVATION — PROJECT CARRYALL. John G. Fry, Roy A. Stane, and W. H. Crutchfield (Atchison, Topeka and Santa Fe Railway Co., Chicago). (CONF-378-3)

From 43rd Annual Meeting, Highway Research Board, Washington, D. C., Jan. 1964.

A feasibility study was conducted on the use of nuclear explosions to cut through the Bristol Mountains for the realignment of a Santa Fe railroad and a California highway (Interstate 40). The proposed cut would be about 11,000 ft long with a maximum depth of about 350 ft, and in a tentative design this cut would be made by detonation of a row of 22 nuclear explosives with a total yield of 1730 kt. Additional site investigations are needed. (D.L.C.)

12290 (UCRL-7632(p.17-20)) OPERATIONS AND SAFETY PROBLEMS ASSOCIATED WITH A NUCLEAR EXCAVATION PROJECT. Harlan Zodtner (California. Univ., Livermore. Lawrence Radiation Lab.). (CONF-378-4)

From 43rd Annual Meeting, Highway Research Board, Washington, D. C., Jan. 1964.

A description is given of the operation and safety problems involved in a possible project for cutting through the Bristol Mountains in California for a highway and a railroad (Carryall Project). Among the items discussed are shot time safety and control, fallout, radioactivity decay, close-in and long-range air blast, ground shock, and dust, rocks, and ejecta. A proposed time schedule of about 5½ years is given for Carryall Project. (D.L.C.)

12291 (UCRL-7632(p.21-4)) CONSTRUCTION AND FEASIBILITY ASSOCIATED WITH NUCLEAR EXCAVATION. H. C. Prentice and E. J. Peterson (California. State Div. of Highways, Sacramento). (CONF-378-5)

From 43rd Annual Meeting, Highway Research Board, Washington, D. C., Jan. 1964.

The construction activities which would be conducted after the Carryall excavation are described briefly. It is suggested that an additional single nuclear crater be made to take care of the drainage problem at the east end of the proposed cut. Costs of the nuclear excavation are estimated and compared with those of conventional excavation. It is concluded that Carryall Project is technically feasible, but that planned Plowshare excavation projects (Buggy, Schooner, and Galley) should be conducted in advance. (D.L.C.)

Facilities and Equipment

12292 (CNLM-5205) INVESTIGATION OF CAVITATION DAMAGE OF MECHANICAL PUMP IMPELLERS OPERATING IN LIQUID METAL SPACE POWER LOOPS. Quarterly Progress Report No. 2, October 1, 1963 – December 31, 1963. R. S. Kulp and J. V. Altieri (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). Jan. 15, 1964. Contract NAS3-2541. 42p.

Water testing of the RI-7C3 impeller in the Pt-2 test stand was completed. Still photographs and movies showed that a vortex was present on the leading edge tip of all blades at NPSH values up to 150 ft at all five test flows of 660, 680, 700, 720, and 740 gpm. Sound data showed a possible correlation with the cavitation performance of the impeller. The sound intensity increased until the tip vortices entered the flow channels and then decreased, reaching a minimum just before head loss occurred. As the head fell off, the sound intensity increased to a level as great or greater than the previous maximum. The TP-1 turbopump detail parts required to complete the assembly of the pump in its modified form were completed. The turbopump was assembled with the tested impeller and installed in the PT-4 water pump test stand. The pump was operated at low speed to assure proper seating of the seals and testing started. The PT-6 liquid metal test stand construction drawings were completed. Construction of the test stand was started by disassembling, cleaning, and acid pickling the entire loop piping. Reassembly of the test loop was started. (N.W.R.)

12293 (N63-15259) RESEARCH ON FUNDAMENTAL ELECTRODYNAMIC AND HYDRODYNAMIC PHENOMENA INVOLVED IN ELECTROMAGNETIC PUMPING OF LIQUID METALS. Final Report, Period Ending March 31, 1962. G. R. Findlay (Liquid Metals, Inc., Westford, Mass.). Contract NASr-33. 123p.

A theoretical analysis of the fundamental principles of magnetohydrodynamic flow of liquid metals in any type electromagnetic pump is presented. The inherent advantages and potential limitations of each of four types of electromagnetic pump are discussed along with the major problems that affect design of a light-weight, efficient, and reliable pump. A study made of the various pumping requirements is reported. The potential areas of application for different type EM pumps in these space power plant systems are indicated. A detailed circuit analysis is made for the electrodynamic type pump. In addition, an example is presented of the weight and weight penalty possible for

the electrodynamic pumps that might be used in a potentially typical 2,000 kw(e) nuclear turbodynamic space power plant system. To supplement theoretically calculated performances of a number of electrodynamic pumps, an exploratory experimental program is presented and discussed. This program includes performance measurements on six different types of electrodynamic pumps covering flow ranges to 65 gallons/minute with developed pressure to 250 psi and operating temperatures to 1400°F, and with sodium, NaK, and potassium as the working fluid. The problem areas recognized during the study as requiring more basic experimental data before an efficient light-weight, reliable pump can be designed are called to attention. Useful data for system and component optimization studies are presented in graphic form. (auth)

12294 A PHOTONEUTRON LABORATORY FOR EXPERIMENTS WITH HIGH-ACTIVITY SOURCES. Yu. Ya. Stavisskii, A. I. Abramov, T. S. Belanova, A. A. Van'kov, and V. P. Koroleva. At. Energ. (USSR), 15: 489-93(Dec. 1963). (In Russian)

Measurement of weak effects, such as determination of neutron capture cross sections by Fe or Ni, requires the use of relatively large sources. In order to carry out such experiments safely, a remotely operated laboratory was placed in service. The cells were designed for experiments with spherical geometry, with provisions also made for cross section measurements by the activation method and for determination of the angular distribution of scattered neutrons. The concrete shielding of the walls and the doors was designed for handling sources up to 1000 curie. Automatic equipment, making possible remote assembly of equipment and source transportation, was installed in both cells. A large water container is part of the experimental equipment. In the large cell, the neutron flux was measured by means of 4 elongated counters placed at any distance from the source. The high-quality manipulators make it possible to repeat the operations with excellent precision. The first experiments involved the determination of the effective neutron capture cross section of Cu, Zr, and Mo, using a (Sb–Be) source. (TTT)

12295 ON THE EXAMPLE OF SACLAY WATER REQUIREMENTS OF A NUCLEAR CENTER. J. Aldebert. Eau, L, 50: 242-7(May 1963). (In French)

Water requirements are enumerated, using the Saclay Center as an example, and the provisions for satisfying the requirements are discussed, together with the unique requirements on the water distribution system of such a center. Future demands are indicated. (D.C.W.)

12296 THE TREATMENT OF SUPPLY WATERS: THE HEAT EXCHANGERS OF G2 AND G3, THE FACILITY FOR STORAGE AND DECLADDING AND THE BOILERS IN THE PLUTONIUM EXTRACTION PLANT. J. Bouchard. Eau, L, 50: 272-7(May 1963). (In French)

The treatment of water for the cooling circuits of the G2 and G3 reactors, the pool in which irradiated fuel elements are stored and decladded, and the boilers of the extraction plant is described, together with the equipment used. The particular requirements on water for each use are discussed, and the properties of the initial Rhone water are given. (D.C.W.)

12297 CONNECTOR TOOL [SAND-4] (Engineering Materials). (Sandia Corp., Albuquerque, N. Mex.). (CAPE-541)

This package contains 3 drawings and 1 photograph. The tool was developed to facilitate removal of contacts from the bodies of removable contact connectors for modification or reuse. The tool is a spring-loaded device with which contacts can be removed by a simple action from one side of the connector. (F.S.)

12298 DENSITY BALANCE WITH HOOD (Engineering Materials). (Argonne National Lab., Ill.). (CAPE-1069)

This package contains 32 drawings. The remotely controlled, hot laboratory equipment consists of a standard balance and a specially designed density measuring apparatus. Density measurements are obtained by immersing a specimen in a liquid-filled Dewar flask. The flask is unsilvered and has a capacity of 7200 ml. The critical parts of the weighing apparatus are enclosed in a hood to prevent air currents from affecting the weighing operation. The Mettler balance is enclosed in a hood, which rests on top of the other hood. Metal frames and lucite or metal panels are used. The apparatus is used in an alpha-gamma cave. (F.S.)

12299 HYPERSONIC WIND TUNNEL COMPONENT DESIGN (SAND-47) (Engineering Materials). (Sandia Corp., Albuquerque, N. Mex.). (CAPE-1073)

This package contains 4 drawings. The hypersonic 18-in. wind tunnel is an intermittent, vacuum-receiver exhaust, blowdown-type with a test section 18 in. in dia and 48 in. long. The tunnel's scale model testing capabilities are: surface pressure distribution, 2 to 6 component force, free-oscillation dynamic stability, and model surface heat-transfer rate. The maximum model size that the tunnel can accommodate is 4 in. in dia. The components are the pressure seal for the 16-in. dia slide valve, balance cell assembly, suspension and translation system, and the refractory installation in the 90-in. pebble bed heater. (F.S.)

12300 NET-1 NETWORK ANALYSIS PROGRAM (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE-1082)

This package consists of 19 flow charts to be used for the MANIAC II Computer to simulate the d-c steady state behavior of a large class of electrical circuits, which may contain passive and solid-state components. Circuits described to NET for analysis may include the following elements connected in any manner so long as the connections remain fixed: junction transistors and diodes; signal and fixed voltage sources; and fixed-value resistors, capacitors, inductors, and mutual inductive couplings. The NET program makes it possible to determine variations of circuit response due to changes in circuit parameters. Destructive transient phenomena may be studied with no fear of destroying expensive transistors. (F.S.)

12301 ZONAL CENTRIFUGE, A-IX (Engineering Materials). (Oak Ridge Gaseous Diffusion Plant, Tenn.). (CAPE-1083)

This package contains 3 drawings. The centrifuge was developed under the joint National Institute of Health–Atomic Energy Commission Zonal Centrifuge Development Program. It is used in a program seeking zonal centrifuge systems for the separation of cells and subcellular particles including viruses and biocolloids. The Al rotor of the A-IX centrifuge permits higher speeds and more stable operating conditions than the A-V rotor which it replaces. This rotor is used with the PR-2 centrifuge drive. Thick transparent lucite end caps permit visual study. The 1300 ml rotor volume is divided into eight lucite sector-shaped compartments. The central lucite core is a single 45° cone. Flow lines to the rotor edge pass over the lucite septa, thus leaving the entire sector-shaped compartment unobscured. The centrifuge is designed for a speed of 6000 rpm and is satisfactory when

used as a continuous flow-device for large particles as well as a rate-zonal centrifuge. Flow rates of 1 liter/min appear feasible with low-viscosity materials. (F.S.)

12302 HIGH TEMPERATURE CURRENT CONCENTRATOR (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE-1087)

This package contains 9 drawings. The current concentrator is a high-temperature induction furnace developed for use with 20 kw, 450 kc radiofrequency generators. Its use is not necessarily limited to the stated power level and operating frequency. The design incorporates a transformer that can be adjusted to match the low electrical impedance of a small charge to that of a generator even if the frequency is as low as 10 kc. The power input is limited by the cooling system to approximately 40 kw. The charge is usually heated directly and resulting temperatures above 3800°C are possible with a power input of 25 kw and no special radiation shielding. The enclosure is made of pyrex. Low internal operating voltage and the absence of power feed-through terminals almost completely eliminate voltage breakdown even under the most adverse operating conditions. (F.S.)

12303 IMPROVEMENTS IN OR RELATING TO APPARATUS SUITABLE FOR THE METALLOGRAPHIC STUDY AND OTHER OPERATIONS ON RADIOACTIVE MATERIALS. Jean Blin and Andre Valentin (to Commissariat à l'Energy Atomique). British Patent 947,074. Jan. 22, 1964. Priority date Nov. 6, 1959, France.

A shielded production line, especially designed for the metallographic study of radioactive materials, is patented. Sealed transportable cells are placed in series in a shielded enclosure. A sealed remotely controlled conveyor connects the cells together and can be joined to openings in the cells for transferring materials without breaking the airtightness of the cell. The apparatus also includes remotely controlled manipulators for performing operations within the cells, windows in the cell and enclosure walls for viewing operations, remotely controlled devices to move the cells into a decontamination region adjoining the enclosure, and arrangements for the introduction and circulation of inert gas in the cells and conveyor. Details of the design of the apparatus are described. (M.P.G.)

12304 IMPROVEMENTS IN ULTRACENTRIFUGES. (to Reactor Centrum Nederland). British Patent 947,892. Jan. 29, 1964. Priority date Mar. 22, 1960, Netherlands.

An ultracentrifuge for the separation of gaseous mixtures is patented. The drum of the centrifuge is supported at its lower end for rotation about a vertical axis and is held in an upright position by magnetic suspension near the upper end. The drum is driven by an asynchronous rotary-field motor, the armature of which is a cylindrical sleeve of electrically conducting nonmagnetic material fixed to and coaxial with the drum. The armature extends into an annular gap formed by the stator, which is 2 concentric ferromagnetic members. The outer member of the stator carries windings for generating a rotary field, and the core member is made of a ferrite material with small hysteresis losses. (M.P.G.)

12305 IMPROVEMENTS IN AND RELATING TO REMOTELY CONTROLLED GAS-OPERATED GRABHEADS. Reginald William Creear and John Anthony Collis-Smith (to English Electric Co. Ltd.). British Patent 948,733. Feb. 5, 1964. Filed June 19, 1959.

A remotely controlled gas-operated gripping device is described that features a plurality of movable jaw members and a nonreturn gas reservoir. (R.E.U.)

12306 A HEAT EXCHANGE ASSEMBLY AND HEAT EXCHANGES INCORPORATING THE SAME. Andre Huet. British Patent 949,778. Feb. 19, 1964. Priority date Mar. 9, 1959, France.

A heat-exchange assembly was developed in which a main fluid duct terminating in a distribution center connects with a plurality of identical passages by way of a network of conduits that extends between the distribution center and the plurality of passages to complete a plurality of fluid flow paths from the main fluid duct to each passage. The fluid-flow paths are of equal resistance to fluid flow. Two of these assemblies are used in a heat exchanger. (M.C.G.)

12307 IMPROVEMENTS IN OR RELATING TO TUBE AND PLATE ASSEMBLIES. Kenneth Marsh Hill (to United Kingdom Atomic Energy Authority). British Patent 949,931. Feb. 19, 1964. Filed Aug. 11, 1959.

A tube and plate assembly such as are used in heat exchangers was developed in which the tube is sealed to a skirt around a hole in the plate by way of an intermediate coupling. The hole is of larger diameter than the tube and the intermediate coupling has a tubular part corresponding in diameter to the skirt around the hole in the plate. The intermediate coupling is butt welded at its tubular part to the tube and at the skirt on the end flange to the skirt around the hole in the plate. The tubular part of the intermediate coupling, together with the tube passes through the hole in the plate. (M.C.G.)

12308 RADIOACTIVE SOURCE HANDLING APPARATUS WITH SHOCK ABSORBING MEANS FOR HOLDING AND RELEASING RADIOACTIVE PELLETS. Fred Maud and Thomas Horne (to The Budd Co.). U. S. Patent 3,123,713. Mar. 3, 1964. Filed Sept. 23, 1960.

A source-handling device is described for propelling and capturing radioactive sources in tubes and is provided with shock-absorbing material to protect the source from rupture upon abrupt stopping. (R.E.U.)

12309 ULTRA-HIGH PRESSURE DEVICE. R. P. Levey, Jr. (to U. S. Atomic Energy Commission). U. S. Patent 3,123,862. Mar. 10, 1964.

A device for attaining isostatic pressures exceeding 1,000,000 psi is described. A plurality of anvil members are adapted to converge upon a die member having a stepped interior pressure chamber to provide lateral support thereto. High-pressure fluid provides lateral support to the reduced-diameter portion of a stepped piston member slidably positioned within the stepped pressure chamber of the die member. (AEC)

Heat Transfer and Fluid Flow

Refer also to abstracts 13247 and 13253.

12310 (ACNP-64002) INVESTIGATION OF VAPOR VOLUME FRACTION AND SLIP VELOCITY UNDER THE EURATOM PROGRAM. Quarterly Progress Report, October 1, 1963–December 31, 1963. (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). Jan. 17, 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(11-1)-1272. 29p. (EURAEC-956)

Average vapor volume fraction (void fraction) and volume fraction profile data were obtained for eight different flow conditions in a three-inch test section. The flow parameters included pressures of 600 and 1000 psi, average void fractions of 0.30 and 0.50, and superficial liquid velocities

of 1.0 and 2.5 ft/sec. The average void fractions from the integrated gamma attenuation traverses were compared with average voids determined using a manometer technique and the agreement was good at the low velocities tested. Profiles calculated from an exponential model were fit to the void fraction profile data. It was found that the 1000 psi data could be fit with an exponent of approximately 0.3 and the 600 psi data with an exponent of approximately 0.4. (auth)

12311 (AERE-M-1321) X-RADIOGRAPHY OF TWO-PHASE GAS-LIQUID FLOW. R. T. P. Derbyshire, G. F. Hewitt, and B. Nicholls (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Jan. 1964. 7p.

Preliminary results are presented from the application of X radiography to the study of flow patterns in two-phase flow. These are very encouraging and seem to justify the extension of the technique to a wide range of two-phase flow problems. Probable lines of future development are outlined. (auth)

12312 (ASD-TDR-63-842) AN EXPLORATORY INVESTIGATION OF THE EFFECTS OF IONIZATION ON THE FLOW AND HEAT TRANSFER WITH A DENSE GAS. Henry R. Velkoff (Research and Technology Div. Air Force Aero-Propulsion Lab., Wright-Patterson AFB, Ohio). Aug. 1963. 103p.

An investigation of the effects of ion motion on the pressure drop and heat transfer of a gas flowing in a channel was undertaken. Air and other gases were ionized within the channel and an electrostatic field was applied normal to the flow direction. Increases in pressure drop and heat transfer of the order of two to one were found with the application of the field. It was also observed that the velocity profiles in the channel were greatly distorted due to the action of the field. Extensive data are presented on the variation of friction factor, velocity profile, and heat transfer with ion current. The significance of these results lies in the fact that large changes were observed when the ionization level is very low, of the order of 1 ion to 10^9 neutrals in gas at standard conditions. (auth)

12313 (CONF-187-72) AUTOMATIC EXIT STEAM QUALITY CONTROL FOR BOILING WATER REACTORS. D. A. Gall and E. F. Doyle (Dynatech Corp., Cambridge, Mass.). [1963]. Contract AT(30-1)-2907. 15p.

From American Nuclear Society Meeting, New York, Nov. 1963.

The need for control of the flow distribution and/or steam quality in boiling reactors is discussed. A quality control device is being developed which consists of an entrance venturi and an exit venturi for measuring the flow rates into and out of the channel, means for comparing the two flow rate signals, and a value for regulating the flow rate. This device can be used either as a constant-quality device or as a controlled-quality device. Results are given of air-water studies of two-phase flow in a vertical venturi. (D.L.C.)

12314 (IDO-11006) BIPHENYL LIQUID HEAT TRANSFER AND VAPOR DEPOSITION STUDIES AT 700° AND 800°F. Final Report, February 1961–May 31, 1963. C. D. King, Jr., and W. J. Moodie (Monsanto Research Corp. Dayton Labs., Ohio). Aug. 1, 1963. Contract AT(10-1)-1088. 104p.

Heat transfer studies were made on biphenyl in a large stainless steel heat transfer test loop (1 inch I.D. × 5 ft long heat transfer section). Correlations were developed for both convective and boiling heat transfer, including surface and bulk boiling, over the temperature range 413.0 to 805.5°F at heat fluxes from 10,600 to 110,200 Btu/hr × ft^2. A Dittus-Boelter type equation was used to correlate the convective data and a Levy type equation for the boiling data. Turbine construction alloys were found to be unaffected by 320-hr exposure to high velocity superheated biphenyl vapor at 700°F. Some adhering solid deposits were probably the result of entrained liquid containing dissolved or suspended metallic compounds. An IBM-704 computer program was written for calculation of heat transfer and flow rates under thermosiphon conditions. (auth)

12315 (NAA-SR-Memo-9172) NAA PROGRAM DESCRIPTION — ANGULAR MOMENTUM OF FLUIDS FLOWING THROUGH PIPES. J. G. Morgan (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 1963. Contract AT-11-1-GEN-8. 66p.

Described are two modified versions of a computer code written by Thompson-Ramo-Wooldridge for calculating the angular momentum of fluids flowing through straight pipes and pipes with a constant radius of curvature. The first version is the Thompson-Ramo-Wooldridge code modified to run in the North American Aviation computing system on an IBM 7094. It also contains modifications to the input and output statements, formats, and flow rate conversion factor. The second version is for dimensional tolerance studies of the pipes using a random process. This version includes two additional subroutines. (auth)

12316 (NYO-9650) A PHOTOGRAPHIC STUDY OF BOILING FLOW. John H. Vohr (Columbia Univ., New York). Oct. 25, 1963. Contract AT(30-3)-187. 198p.

A high speed motion picture study was conducted of boiling flow in a vertical, rectangular channel at atmospheric pressure. Three different visual flow regimes were defined and described. These were: bubble flow, coalescing flow, and slug-annular flow. Photographs are presented of all these regimes. An original technique for measuring two-phase flow velocities was developed, and velocity measurements were made in all the flow regimes listed above. These measurements indicated the presence of substantial liquid superheating in the bubble and coalescing flow regimes and also provided part of the basis for the development of a model for slug-annular flow. A quantity denoted as flow pattern scale was defined and measured. This quantity is, essentially, a measure of the characteristic size of the vapor and liquid volumes composing a flow pattern. It was found that the different flow regimes could be quantitatively characterized by means of the scale values associated with them. A model for slug-annular flow was advanced, based on velocity measurements and study of the motion pictures of the flow. Pressure gradients predicted on the basis of this model were found to agree very well with measured values. (auth)

12317 (NYO-10702) AN EXPERIMENTAL STUDY OF PARTICLE-FLUID HEAT TRANSFER IN A WATER FLUIDIZED SYSTEM. J. P. Holman, T. W. Moore, and V. M. Wong (Southern Methodist Univ., Dallas. School of Engineering). Oct. 1963. Contract AT(30-1)-2751. 125p.

Studies were made to establish correlations for predicting convection heat transfer coefficients from fluidized particles to water. The correlation type $Nu = C(ReF_\epsilon)^a Pr^b (D_T/D_p)^{0.5} (\rho_f/\rho_p)^d$ was used to correlate the heat transfer data for many different fluidized sys-

tems. Two different correlations were derived for linear and nonlinear test section temperature distributions. A comparison between experimental and calculated cooling curves showed that the linear water temperature distribution is more nearly correct; for this distribution, $C = 3.07 \times 10^{-6}$, a = 2, b = 1.5, and d = 2. (D.L.C.)

12318 (TRG-Report-546) LIQUID METAL HEAT TRANSFER BY FORCED CONVECTION. A Literature Survey. R. Herrick (United Kingdom Atomic Energy Authority. Reactor Group, Risley, Lancs, England). July 2, 1963. 22p.

A study was made of the literature on heat transfer by liquid metals under forced-convection conditions. Theoretical and experimental work dealing with several of the most important heat transfer configurations is described and discussed. Recommendations are made as to the most appropriate heat transfer relationships for use in design calculations. (auth)

12319 (WCAP-1811(Rev.)) THERMOELECTRIC HEAT EXCHANGER DEMONSTRATION UNIT. Final Report. Joseph C. Danko (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Jan. 1962. Contract AT(30-3)-500. 28p.

The feasibility of a water-to-water thermoelectric heat exchanger was demonstrated. A seven-tube cluster of state-of-the-art swaged thermoelectric elements was fabricated from n- and p-type Pb–Te. The heat exchanger was operated at pressurized water temperatures of 450, 500, 550, and 600°F with secondary water exit temperature of 100, 150, and 200°F. The design electrical output of 378 watts, 8.9 volts open circuit, 4.4 volts to matched load with 86 amps and 3.6% efficiency was not achieved. The heat exchanger delivered 80 watts, 8.5 volts open circuit, 3.6 volts and 22 amps under essentially matched load conditions and 1.3% efficiency. The best individual tubular thermoelectric elements delivered efficiencies of 2.35 and 2.28%. The test data were analyzed. The factors that contributed to the difference between the design output and measured outputs are discussed. (auth)

12320 BREHMSSTRAHLUNG STUDY OF THE PHASE COMPOSITION OF THE VAPOR-WATER MIXTURE IN A PIPE UNDERGOING HEATING. Z. L. Miropol'skii and R. I. Shneerova (Krzhizhanovskii Energy Inst., Academy of Sciences, USSR). High Temp., 1: 93-7(July-Aug. 1963).

Experimental data are given on the true volume steam contents in a vertical pipe with an inside diameter of 7.7 mm, taken by means of the brehmsstrahlung excited by the electron flux from β sources in the walls of the channel. The pressures varied from 20 to 70 kg/cm^2, the weight rates varied from 400 to 3000 kg/m^2·sec, and the heat fluxes varied from 0 to $1.5 \cdot 10^6$ kcal/m^2·hr. (auth)

12321 DEPOSITION OF FISSION PRODUCTS FROM HELIUM GAS FLOWING AT HIGH VELOCITIES. A. Abriss, R. A. Ewing, and D. N. Sunderman (Battelle Memorial Inst., Columbus, Ohio). 16p. (CONF-187-78)

From American Nuclear Society Meeting, New York, Nov. 1963.

Out-of-pile experiments simulating gas cooled reactor flow and temperature conditions were made to correlate by both empirical and theoretical considerations such parameters as Reynolds numbers, velocity, surface conditions, materials of construction, geometry, particulate matter, and fission product diffusion coefficients. It was concluded that all regions of flow disturbance are areas of buildup of activity. No selectivity in deposition among the elements studied, with the exception of I, Te, and Cs, was found. Relative abundances to each other of less volatile isotopes remained constant throughout any particular experiment. Data are tabulated. (P.C.H.)

12322 THE PREDICTION OF VOID VOLUME IN SUBCOOLED NUCLEATE POOL BOILING. E. E. Duke (Internuclear Co., Clayton, Mo.). 23p. (CONF-187-41)

From American Nuclear Society Meeting, New York, Nov. 1963.

A three-step equation was developed that adequately describes the average volume of vapor occurring on a horizontal surface due to nucleate pool boiling of subcooled water. Since extensive bubble frequency data are lacking, the data of others were combined with experimental observations to make predictions of void volume at ambient pressure with various degrees of subcooling. (auth)

12323 ELECTRO-MAGNETICALLY ACTUATED FLUID FLOW CONTROL VALVE. Rene Donguy, Andre Roguin, Jean Guichard, and Paul Julien-Laferriere (to Commissariat a l'Energie Atomique). British Patent 949,577. Feb. 12, 1964. Priority date Nov. 10, 1959, France.

An electromagnetic valve is designed which is rapidly dismantled and reassembled, requires practically no maintenance, can work for long periods at temperatures around 350°C without wet lubrication, and gives a completely fluidtight seal. The valve is particularly suitable for sampling a reactor cooling gas for fission product detection. The valve includes a closure member which is rectilinearly movable between normal and actuated positions, a ferromagnetic core fast with the closure member, control windings for actuating the core, switch means, and a circuit for indicating flow in the valve. (D.L.C.)

12324 METHOD FOR PRODUCING CONTROLLED CIRCULATION OF WATER IN A STEAM GENERATOR, AND A STEAM GENERATOR EMPLOYING THE METHOD. Andre Huet. British Patent 949,608. Feb. 12, 1964. Priority date Mar. 12, 1959, France.

A controlled circulation device is designed for a thermal installation for producing steam from the heat from a reactor, in order to cope with an increased demand for steam for the turbine associated with the installation. The device selectively augments the convective circulation within the evaporator by the forced injection, into the feed water flow at the evaporator inlet, of water which has already passed through the evaporator. (D.L.C.)

Materials Testing

Refer also to abstract 12325.

12325 STANDARDIZATION OF NUCLEAR ENVIRONMENTAL TEST CONDITIONS. Daniel J. Taravella (Picatinny Arsenal, Dover, N. J.). p.641-5 of "Institute of Environmental Sciences, 1963 Annual Technical Meeting Proceedings." Mt. Prospect, Ill., Institute of Environmental Sciences, 1963.

The standardization of testing criteria for missile warheads for the Nuclear Weapons Laboratories is discussed. Examples are given for vibration and packaged drop in the transportation and handling of the warhead and adaptation kit for a nuclear bomb. (R.E.U.)

12326 SYMPOSIUM ON PHYSICS AND NON-DESTRUCTIVE TESTING. THE MÖSSBAUER EFFECT, OCTOBER 1, 2, 3, 1963, SAN ANTONIO, TEXAS. PART II. THE NUCLEUS AND ITS ENVIRONMENT. Charles William

Kocher (The Budd Co., Physical Research Lab., Downingtown, Penna.). 31p. (CONF-310-4)

From Symposium on Physics and Nondestructive Testing, San Antonio, Oct. 1963.

A summary is presented of the important concepts associated with the Mössbauer effect, from the most simple nuclear physics through material applications to some theoretical considerations. The general applications that have been made and are being thought about now by workers in the field, together with some of the specific drawbacks and advantages of this technique, are discussed. (25 references) (auth)

12327 HIGH ENERGY RADIOGRAPHY—1–30 Mev. James H. Bly (High Voltage Engineering Corp., Walnut Creek, Calif.). 28p. (CONF-356-8)

From 1963 American Society of Metals/Materials Show, Cleveland, Oct. 1963.

A survey of the field of radiographic inspection of thick sections, at one million volts energy or more, shows that this field has become a major branch of radiographic testing. More than a dozen models of x-ray generators are now commercially available in this field, over the range from 1 to 31 Mev, with outputs up to more than two orders of magnitude greater than can be obtained from radiographic isotope sources, and with smaller spot size. A study of the radiographic characteristics of x rays in this region shows that energies available cover the range of minimum absorption and scattering for most materials and approach this range for solid propellant; at higher energies severe coverage restrictions are imposed; output powers on small spots are near the limits of present target technology. It would appear that some degree of technological "maturity" has been achieved. Radiographic technique at 1 to 30 Mev is straightforward, following the same basic principles as in conventional radiography. Specialized aspects of technique are individually discussed. The well-known 1 and 2 million volt equipments are supplemented by a wide variety of higher-energy machines, with energy and output ratings to satisfy almost any radiographic need. Some examples are epitomized, and a brief discussion of possible future developments is presented. (auth)

Protective Structures

12328 (AD-416490) ANALYSES OF HEAT DISSIPATION TECHNIQUES FOR PROTECTIVE SHELTERS. Technical Note N-523. J. M. Stephenson and C. L. Herndon (Naval Civil Engineering Lab., Port Hueneme, Calif.). July 15, 1963. 12p.

Seven cooling techniques were investigated and analyses were made to determine how practical each technique would be if incorporated into a 100-man shelter. The techniques were as follows: buried pipe grids using water as the heat transfer medium, a crushed rock heat sink using air as the heat transfer medium, vapor compression and absorption systems, well water, ice storage utilizing mechanical refrigeration, compressed air, and liquid oxygen. Each system was examined with respect to the length of time it could be effectively operated, and its auxiliary requirements. None of the techniques appears to be satisfactory in all respects; however, the use of well water is very attractive providing it is readily available at a cool enough temperature. Since power requirements are closely allied with cooling systems the problems associated with power supplies are discussed. A discussion is given of the total energy concept utilizing gas turbine package systems. (auth)

Vacuum Engineering

12329 (ORNL-3564(p.126-9)) VACUUM SYSTEMS, TECHNIQUES, AND MATERIAL STUDIES. J. D. Redman, D. M. Richardson, and R. A. Strehlow (Oak Ridge National Lab., Tenn.).

Results from a study of ionization gage sensitivity as a function of emission current led to a method of determining the presence of gage contributions of gas or of pumping. Low-energy (30 v) electron ionization of organic compounds was found to simplify significantly the mass spectra of hydrocarbon components of a vacuum system. (auth)

12330 ALICE "B" 60 kv SOURCE 6" ELBOW TRAP (Engineering Materials). (California. Univ., Livermore. Lawrence Radiation Lab.). (CAPE-980)

This package contains 1 drawing. The ultra-high vacuum trap consistently produces pressures of 1×10^{-10} Torr and at times 1×10^{-11} Torr. It has an optically opaque, two-bounce baffle, an oil migration barrier, aluminum foil gaskets, minimum heat leaks to the baffle and to the liquid-nitrogen ports, and an elbow baffle to prevent the cold baffle from "seeing" the mouth of the diffusion pump. It is bakeable to 400°C and is easily disassembled for cleaning. The traps are used with commercially available 6-in. oil diffusion pumps. (F.S.)

12331 MOLECULAR BEAM EXPERIMENT VERTICAL CIRCULATING LN-BAFFLE, 4 IN. (Engineering Materials). (California. Univ., Livermore. Lawrence Radiation Lab.). (CAPE-981)

This package contains 1 drawing. The baffle is used with a 4 in. oil diffusion pump in a molecular beam experiment to produce pressures as low as 1×10^{-10} Torr. The optically opaque, two-bounce baffle has the following features: an oil migration barrier, aluminum foil gaskets, minimized heat leak to the baffle and to the liquid-nitrogen ports, a vacuum insulation neck for the nitrogen transfer lines, and a diffusion pump port cover which can be closed during start-up of the pump thereby preventing slugs of oil from hitting the cold baffle. The baffle is bakeable to 400°C and is easily disassembled for cleaning. (F.S.)

12332 MECHANICAL MANIPULATOR FOR VACUUM SYSTEM (Engineering Materials). (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). (CAPE-1067)

This package contains 4 drawings. The mechanical manipulator is used with a vacuum chamber for electron beam welding. The manipulator consists of an aluminum pistol grip and a steel rod housing. This tube contains the drive rod. It enters the chamber by a ball and socket. The steel ball is held by a brass ball retainer. The clamp assembly is 10 in. long and opens to 3 in. (F.S.)

12333 THE ROLE OF CRYOGENICS IN THE PRODUCTION OF HIGH AND ULTRA-HIGH VACUUM. L. O. Mullen and M. J. Hiza (National Bureau of Standards, Boulder, Colo.). 29p. (CONF-110-2)

From American Institute of Chemical Engineers 56th Annual Meeting, 1963 Annual Meeting, Houston, Tex., Dec. 1963).

The role of cryogenics in producing ultrahigh vacua is discussed with application to unbaked, elastomer-flanged systems. The types of gas loads encountered in typical systems, some of the recognized limitations of conventional diffusion pumps, and advantages and limitations of cryogenic methods of pumping are discussed. 33 references. (R.E.U.)

GEOLOGY AND MINERALOGY

General

Refer also to abstract 12568.

12334 (DASA-1357(Vol.IV)) UNDERGROUND EFFECTS OF NUCLEAR WEAPONS IN THE CLOSE-IN REGION. Final Report. G. F. McDonough, Jr. (Plesset (E. H.) Associates, Inc., Santa Monica, Calif.). Mar. 14, 1963. Contract DA-49-146-XZ-073. 180p. (AD-403073)

The following items are included: the derivation of the Hugoniot equation of state, the statistical determination of the equation of state at high pressures, elastic half-space analysis of ground motion, the Gilbert Rayleigh-wave solution of the transient response of the elastic solid half-space to surface pressures, tables of rock properties, equations for axially symmetric wave propagation in soil, and analysis of the problem of a uniform exponential pressure pulse in a cavity. (D.L.C.)

12335 (IDA/HQ-63-1345) DEPTH OF FOCUS DISCRIMINATION BY CRUSTAL PHASES FOR NTS NUCLEAR EXPLOSIONS. Research Paper P-12. John DeNoyer (Institute for Defense Analyses, Washington, D. C.). Mar. 1963. 14p. (AD-406082)

Time residuals for Pg–Pn intervals as a function of epicentral distance and Sg–Pa intervals are examined for 'calibrated' source-to-recording-station paths. At some stations, it is found that the residuals are reduced by about one-half when true epicentral distance is used. Depths of foci for 16 nuclear explosions are estimated from Pg–Pn residuals. When the average is taken for depth estimates from three or more recording stations, the results are within 10 km of the surface. Depths computed from single stations may be as much as 30 km in error. The greatest source of error is in reading arrival times of the Pg phase with sufficient accuracy from LRSM three-component recordings. (auth)

12336 (PG-Report-550) THE BIOLOGY OF THE SOLWAY FIRTH IN RELATION TO THE MOVEMENT AND ACCUMULATION OF RADIOACTIVE MATERIALS. VII. SEA BED AND SEA SURFACE DRIFTER RELEASES. A. SOLWAY FIRTH, 1962. M. Bailey, E. J. Perkins, and B. R. H. Williams (United Kingdom Atomic Energy Authority. Production Group. Chapelcross Works, Annon, Dumfriesshire, Scotland). 1964. 64p.

Releases of sea bed and sea surface drifters in the Solway Firth, during the period August 28 to October 19, 1962, are described. It was shown that, while the sea surface drifters tend to disperse seawards, sea bed drifters tend to move upstream. In the latter case, the movement may be modified depending upon the position of the release relative to a line drawn from Southerness Point to Dubmill Point. Primary transport of the sea bed drifter is probably due to tidal mechanisms; the wind has been found to have an effect in modifying the pattern of the returns. (auth)

12337 (TID-20083) CREEP CLOSURE OF A SPHERICAL CAVITY IN AN INFINITE MEDIUM (WITH SPECIAL APPLICATION TO PROJECT DRIBBLE, TATUM SALT DOME, MISSISSIPPI). A. P. Boresi and D. U. Deere (Illinois. Univ., Urbana). May 1, 1963. For Holmes and Narver, Inc., Las Vegas, Nev. 88p.

The results of triaxial compression tests and creep tests on cores from Tatum Dome are used to assess the probable behavior of the cavity to be excavated at a depth of 2000 ft at Tatum Dome. A theory of closure of a spherical cavity in an infinite medium is developed, and a computer program for solving the equations is described. Typical results are presented which illustrate the rate of closure and stress distribution pattern at various times for the Tatum Dome cavity. (D.L.C.)

12338 (TID-20200) PRELIMINARY REPORT ON THE SEDIMENTS AND RADIOACTIVITY IN THE VICINITY OF THE COLUMBIA RIVER EFFLUENT. Brown Bear Cruise 291, July 29–August 12, 1961 and Brown Bear Cruise 311, July 23–August 14, 1962. Technical Report No. 84. M. Grant Gross, Dean A. McManus, and Joe S. Creager (Washington. Univ., Seattle). Jan. 1963. Contracts AT(45-1)-1725 and Nonr-477(10). 35p. (AD-404020; M63-2)

The sediments in the area affected by the runoff from the Columbia River were studied to determine the distribution of sediment types and the presence and amount of radioactivity in the sediments. The study of the dispersal processes and distributional patterns of the sediment and its radioactivity is in the initial phase of a three-phase program. Various sedimentological analyses of 178 samples provided preliminary data on sediment distribution. The inner part of the continental shelf is covered with sand which grades into silt along the outer part of the shelf. The sediment of the abyssal plains is principally a silty clay, although local coarsening of the sediment is produced by the accumulation of microorganisms. The presence of quartz sand in samples from the abyssal plain appears to be restricted to those samples collected from deep-sea channels. Analyses of the gamma spectra of sediments collected near the Columbia River mouth in 1961 indicate that radionuclides, in addition to the naturally occurring K^{40}, are present in the sediments. The sandy sediments from Grays Harbor and the beaches adjacent to the Columbia River had very low activities although Cr^{51}, Zn^{65}, Co^{57}, and Co^{60} were detected. (auth)

12339 NEW DATA ON THE AGE OF GRANITOID INTRUSIONS OF CENTRAL PAMIR. A. S. Avrashov, A. Ya. Krylov, and Yu. I. Silin. Dokl. Akad. Nauk SSSR, 153: 1136-9(Dec. 11, 1963). (In Russian)

The potassium-argon method was used to determine the absolute age of three granitoid intrusions in Central Pamir. The intrusions were 2 to 4 km wide, and 10 to 40 km long. The potassium content in the mineral was determined by dipycrylamine, and argon by a volumetric method with mass-spectrometric control of the argon composition. The value of λ_K was assumed to be 5.72×10^{-11} in calculating the age of the mineral. Age determinations were run on individual minerals such as biotite, sericite, and potassium feldspar, and also on samples of rock. The age of 20 separate samples varied from 30 to 50 million years. This age shows that the intrusions were formed in the second half of the Paleogene, and consequently, that the intrusion has an Alpine orogenesis. The data show that the biotite was older than the potassium feldspar, and that the granites formed over a considerable period of time. The age data are in agreement with the petrographic data. (TTT)

12340 CARBON AND OXYGEN ISOTOPE RATIOS AS ENVIRONMENTAL INDICATORS: ANOMALOUS RESULTS FROM CARBONATE SHELLS FROM BEACH SEDIMENTS

OF LAKE MANAGUA, NICARAGUA. Jon N. Weber (Pennsylvania State Univ., University Park). Nature, 201: 63 (Jan. 4, 1964).

An example of recent sedimentation that would provide anomalous environmental evidence on the basis of both fossils and carbon and oxygen isotopic composition was found in beach sediments in Lake Managua, near the capital city of Nicaragua. The fresh water mollusks shells are rapidly comminuted by wave action and dissolved by the water, while shells of Anadara, a food clam collected in brackish water environments in the river mouths along the Pacific coast and later transported to the area and discarded in the lake after extraction of soft parts, are buried in the beach sand. (M.C.G.)

12341 RADIOCARBON DATING: A CASE AGAINST THE PROPOSED LINK BETWEEN RIVER MOLLUSKS AND SOIL HUMUS. Wallace Broecker (Columbia Univ., Palisades, N. Y.). Science, 143: 596-7(Feb. 7, 1964).

The C^{14} link between river mollusks and soil humus is discussed. It is stated that the explanation that the C^{13} deficiency should be attributed to the uptake of soil CO_2 by ground water (oxidation of humus in the soil, rather than after it has been transported into streams) and the C^{14} deficiency to the solution of limestone is far more plausible. It was concluded that any relation between the radiocarbon concentrations in soil humus and fresh water mollusks is almost certainly coincidental. (P.C.H.)

12342 YTTRIUM–BERYLLIUM MINERALS OF THE DATOLITE GROUP. E. I. Semenov, V. D. Dusmatov, and N. S. Samsonova (Inst. of Mineralogy, Geochemistry, and Crystal Chemistry of the Rare Elements, Academy of Science, USSR). Soviet Phys.-Cryst. (English Transl.), 8: 539-41(Jan.-Feb. 1964).

The crystal structure, chemical composition, and rare earth content of yttrium–beryllium minerals of the datolite group were investigated. (C.E.S.)

12343 EARTH SCIENCE AND METEORITICS. J. Geiss and E. D. Goldberg, comps. New York, Interscience Publishers, 1963. 325p. $10.50.

Separate abstracts were prepared for 12 of the 15 sections; one was abstracted previously for NSA. Those subjects not included are the history of the earth, rates of sediment accumulation in the Indian Ocean, and thermal effects on the thermoluminescence of limestone. (R.E.U.)

For abstracts of individual sections see: 12344, 12345, 12359, 12360, 12361, 12362, 12363, 12364, 12365, 12366, 12547, and 13118.

12344 THE CONCENTRATION OF COMMON LEAD IN SEA WATER. M. Tatsumoto and C. C. Patterson (California Inst. of Tech., Pasadena). p.74-89 of "Earth Science and Meteoritics." New York, Interscience Publishers, 1963.

Lead concentrations were determined in sea waters off southern California using isotope dilution techniques. In surface waters, dissolved lead concentrations varied from 0.4 to 0.8 μg/liter, with an average of 0.2 μg/liter. In deep waters, the concentrations did not vary much about an average of 0.03 μg/liter. In any given volume of water, lead may be about equally distributed between particulate and dissolved forms, so that the total concentrations of lead may be about twice the values given above. The present rate of introduction of lead to the oceans is twenty-seven times greater than the rate for the Pleistocene, which indicates that the high concentrations of lead in surface waters are caused by industrial contamination, mainly lead tetraethyl combustion products. It can be shown that biological material can serve as an adequate carrier for transporting lead from surface waters to sediments and that the half life of common lead in surface waters is about seven years. The present abnormal rate of lead introduction and the rapid rate of biological removal can be used to predict a lead concentration in surface waters today that agrees closely with observed concentrations. (auth)

12345 RARE GASES IN THE SUN, IN THE ATMOSPHERE, AND IN METEORITES. Peter Signer (Univ. of Minnesota, Minneapolis) and Hans E. Suess. p.241-72 of "Earth Science and Meteoritics." New York, Interscience Publishers, 1963.

The solar abundances of the rare gases are reviewed and mechanisms discussed that can be responsible for the terrestrial rare gas abundances. New data of meteoritic gases are presented. The data on meteoritic primordial gas strongly indicates that the meteorites contain a mixture of primordial rare gases of two different compositions. Carbonaceous and enstatite chondrites contain predominantly fractionated primordial gases of a composition similar to the terrestrial rare gases, whereas the He- and Ne-rich meteorites contain large amounts of an unfractionated component close to solar composition. New estimates of the cosmic abundance of the rare gas nuclides, derived from the primordial rare gases in meteorites, agree well with those derived previously from other evidence. (auth)

Natural Radioactivity and Fallout

Refer also to abstracts 11569 and 12386.

12346 (INSJ-65) DISTRIBUTION OF Th, U, AND K AND RADIOACTIVE HEAT PRODUCTION AS A FUNCTION OF DEPTH WITHIN THE EARTH. Akimasa Masuda (Tokyo Univ. Inst. for Nuclear Study). Jan. 8, 1964. 19p.

From the data on distribution of Th, U, and K in eclogitic rocks analyzed by Heier (1963), the partition coefficients for them were estimated to be 0.0733, 0.182, and 0.552, respectively. The distribution of these elements within the earth was estimated by the use of the partition coefficients obtained and simultaneously the radioactive heat production was also estimated as a function of depth. On the other hand, the primary tholeiite of Japan was suggested to be the product of body melting, not partial melting, of the mantle material which was seated at the depth of 150 km. (auth)

12347 (PL-86) A PRELIMINARY REVIEW OF A FINNISH INTERCOMPARISON PROGRAMME BETWEEN SEVEN LABORATORIES STUDYING FALLOUT ACCUMULATION IN REINDEER AND THEIR ENVIRONMENT. Panel on Standardization of Low Level Activity Measurements, Vienna, October 28-31, 1963. Jorma K. Miettinen (Helsinki. Univ.). 6p.

Preliminary results are presented on the analysis of samples of reindeer meat, reindeer bone, lichen (Chaldonia alpestris), and horsetail (Equisetum fluviatile) for natural α activity, Sr^{90}, and Cs^{137} made by 4 laboratories. (C.H.)

12348 THE RADIOACTIVITY OF THE FIRST SOLID ATMOSPHERIC PRECIPITATIONS IN BUCHAREST DURING THE WINTER OF 1962-1963. I. I. Georgescu, Gh. Teodorescu, V. Voljin, and L. L. Ciohodaru (Polytechnic Inst., Bucharest and Univ. of Bucharest). Acad. Rep. Popular

Romine, Studii Cercetari Fiz., 14: 805-14(1963). (In Rumanian)

The radioactivity of the first solid atmospheric precipitations at Bucharest was studied in order to establish the presence of radioisotopes of Sr, Ce, and Cs. In the interval from Dec. 24, 1962, to Jan. 6, 1963, snow samples were collected at two locations about 2.5 km apart. The β activity was analyzed by chromatographic and radiometric comparison between the snow samples and standard solutions. The γ activity was analyzed for the crude snow samples and for the samples obtained by chromatography. The spectra are compared with the standard spectra. Sr^{90}, Cs^{137}, and Ce^{144} were categorically identified in the precipitations. Indications were obtained of the probable presence of La^{140} and, eventually, of Zr^{95} (Nb^{95}). (tr-auth)

12349 INVESTIGATIONS IN RADIOACTIVE FALLOUT PARTICLES. Th. Franke, A. Kaul, U. Nay, and M. F. Rajewsky (Max Planck-Institut für Biophysik, Frankfurt am Main). Atompraxis, 10: 56-62(Jan. 1964). (In German)

Investigations in radioactive fallout particles, begun in 1961, were continued in 1962. In addition to earlier findings the following radioactive nuclides were detected by gamma spectrometry and radiochemical methods: Mn^{54}, Fe^{59}, Sb^{125}, and Cs^{137}. The existence of Co^{56} and Sb^{124} is highly probable. The mean largest diameter of the particles analyzed by electron microscopy was found to be 4.3μ. The elements Fe and Al were again detected as inactive components of the radioactive particles by x-ray microanalysis at the electron microscope. Investigations still in progress indicate that the radioactive particles are insoluble or only slightly soluble under physiological conditions. (auth)

12350 RADIOACTIVITY LEVELS IN THE MEXICAN REPUBLIC. J. Halvas and A. P. Baez (CNEN, [Ispra]). Com. Nucl. Energia Nucl. (Mex.), [Publ.], No. 153, 29-72 (Dec. 1963). (In Spanish)

The measurement and surveillance of the levels of radioactivity in the air and in the precipitation afford a prompt and direct evaluation of the fission products from nuclear explosions and indicate the fluctuations in the ambient air. While this information does not by itself permit us a direct appraisal of the biological effects from radioactive fallout, it aids in arriving at the basis to be used to determine when and where these studies must be made more intensively and in the last instance, what steps must be taken for the protection of the community. In this study the results are presented of a year of measurements made of atmospheric radioactivity by the network of stations distributed throughout the country and which at the present time comprises fifteen units working on a schedule. Maximum, minimum and average values are given for total beta activity in picocuries/m^3 from mixed fission products. A meteorological analysis of the data obtained is presented. As a result of radioactive fallout all other phases of the environment in contact with the atmosphere were contaminated and for this reason a study was made on foodstuffs and on drinking and superficial waters as these are interconnecting links between th environment and man. Values of strontium-90 in milk are presented. (auth)

12351 Sr^{90} IN HUMAN BONE (DENMARK, 1961-1962). H. Levi (Universitet, Copenhagen), J. Lindemann, and A. Nielsen. Health Phys., 10: 75-6(Feb. 1964).

The results of measurements of Sr^{90} in human bone in Denmark from 1961 to 1962 are presented. S.U. values in children were found to be higher than those in fetuses and show much larger variation. (P.C.H.)

12352 DISTRIBUTION OF NATURAL ISOTOPES OF CARBON IN LINSLEY POND AND OTHER NEW ENGLAND LAKES. Edward S. Deevey, Jr. and Minze Stuiver (Yale Univ., New Haven). Limnol. Oceanog., 9: 1-11(Jan. 1964). (TID-18022)

One product of lake metabolism, the CO_2 that is produced anaerobically, is naturally labeled by its high C^{13} content, but in the presence of carbonates, even the modest amounts found in medium-hard Linsley Pond, such enrichment is not distinctive. Groundwater near the lake is highly charged (175 ml/liter) with CO_2; because its source includes ancient carbonate, it is naturally labeled as C^{14}-poor. Combining these data with estimates of surface inflow, outflow, and other gains and losses of water and carbon, we can account for the C^{14} deficiency observed in hypolimnetic water by a groundwater contribution of the order of 1 liter/(m^2 × day), perhaps less than 1% of the flow expected if the lake were not well insulated by a clay basin seal. Under ice, during the winter of 1961–62, C^{14} depletion of the deep water developed so rapidly as to suggest direct injection of groundwater and its accumulation by gravitational flow; however, groundwater carbon is ordinarily cycled metabolically, as shown by the fact that organic surface mud has an apparent age of 1,000 years. Inadequate knowledge of the hydrology of Linsley Pond interferes with rigorous description of the carbon balance, as does recent strong but irregular contamination of air by artificial (hydrogen-bomb) C^{14}. By 1960, submerged pondweeds and surface waters of several lakes were enriched in artificial C^{14} by less than 5%, while water-lily leaves, which use atmospheric rather than aquatic sources of carbon, were enriched by 22%. Using the enrichment of Linsley Pond, 1.9% per year, as a tracer, we find the invasion of atmospheric CO_2 to be slow, 1.2 moles/(m^2 × yr) [1.4 mg/(cm^2 × yr)]. Contributions from groundwater and from air being small, and metabolism being an internal cycle that is nearly closed, the carbon balance of a small lake is seen as part of the hydrologic cycle and as dominated by bicarbonate in surface runoff. (auth)

12353 TRITIUM CONTENT OF ANTARCTIC SNOW. C. B. Taylor (Dept. of Scientific and Industrial Research, Lower Hutt, New Zealand). Nature, 201: 146-7(Jan. 11, 1964).

Data are reviewed on the tritium content of Antarctic snow collected at various altitudes and seasons. Possible explanations are presented for the high tritium content in some snow samples. (C.H.)

12354 AIR CONTAMINATION THROUGH ATOM BOMB TESTS. Paul Huber (Universität, Basel). Oncologia, 16: 221-9(1963). (In German)

Fission products produced by atomic bomb explosions give rise to local and world-wide radioactive fallout. The local fallout consists of large particles, but from bombs of ~20-kt range the world-wide fallout consists of particles with diameters less than 0.01 mm which are distributed throughout the troposphere, at 10,000 to 20,000 m. Because of the prevailing westerly winds it is distributed over a relatively narrow band and is washed to earth by rains. With bombs in the Mt range the radioactive dust is found essentially in the stratosphere, from where a small portion continuously descends through the tropopause into the troposphere and to the earth. The fallout is readily incorporated into drinking water and foodstuffs, or may be inspired as an aerosol. In Switzerland air concentrations of fallout in 1956 were slightly increased above the normal radiation level, and increased to maxima at the beginning of

1959 and the end of 1961. These maxima were related to French and Russian bomb tests. Although a truly valid evaluation of the biological risk is difficult, a permissible level of 5 rem (gonads and whole body), 30 rem (bone, skin, and thyroid), and 15 rem (other organs) has been established in Switzerland for radiation workers. For the general population these values are less by a factor of 100 (gonads) and 30 (all other organs). The maximum permissible concentration (MPC) in air, water, and foods of any radionuclide depends on its metabolism. For Sr^{90} the MPC(air) is 3 pC/m^3, and for tritium the MPC(air) is 50,000 pC/m^3. The MPC (air) for mixed uranium fission products at 10 days is 506 pC/m^3, and at 365 days it is 92 pC/m^3. For I^{131} the MPC(air) is 100 pC/m^3, but because it is incorporated into milk the I^{131} hazard to small children is about 1000 times greater from this source than from respiration. At an air contamination of 0.07 pC/m^3 of I^{131} milk contains an MPC of 130 pC/l. The present value of ~3 pC/m^3 for mixed fission products is much less than the MPC(air) of 229 pC/m^3. This present value does not endanger the population, but steps must be taken to control bomb tests. (BBB)

12355 FISSION PRODUCT GAMMA ACTIVITY IN AIRBORNE PARTICULATES. THE 80th MERIDIAN NETWORK, MARCH AND APRIL 1963. William R. Collins, Jr. (Health and Safety Lab., AEC). Radiol. Health Data, 4: No. 9, 437-40(Sept. 1963).

Data are summarized on fission product γ activity in airborne particulates collected at 15 stations along the 80th meridian during March and April 1963. The stations sampled about 1400 ft^3 of air per day on 8-in.-dia polystyrene filters. A photograph of the sampling equipment is included. (C.H.)

12356 INTERCALIBRATION OF THE MAJOR NORTH AMERICAN AIR MONITORING SYSTEMS. L. B. Lockhart, Jr., and R. L. Patterson, Jr. Radiol. Health Data, 5: No. 1, 12-15(Jan. 1964).

Five major air radioactivity monitoring networks operating in North America were intercalibrated. Interconversion factors were derived for use in comparing the radioactivity concentrations reported by monitoring networks operating in the U. S., Canada, and Mexico. (C.H.)

12357 UMWELTRADIOAKTIVITAT UND STRAHLENBELASTUNG. BERICHT III/62. (Environmental Radioactivity and Radiation Burden. 3rd Quarterly Report, 62). Bad Godesberg, Ger., Bundesminister für Wissenschaftliche Forschung, 1962. 285p. 8.00 DM.

The content of radioactive materials in air, water, soil, and food and the radiation burden to the population of the Federal Republic of Germany for the third quarter of 1962 are reported. Results from monitoring the air and environmental radiation, fallout and precipitation, surface water and waste water, drinking water and sea water, soil, and food are shown in tables and graphs. The content of radioactive material in the human body was also studied. (M.C.G.)

12358 RADIOAKTIVNOE ZAGRYAZNENIE POCHVY I RASTENII. (Radioactive Contamination of Soil and Plants). R. M. Aleksakhin. Moscow, Publishing House of the Academy of Sciences, 1963. 132p.

Fallout contamination of soil and plants is discussed. Data on fallout rates and plant uptake following nuclear explosions are given. The significance of Pu^{239} uptake by plants, biological effects of fission products (Sr^{90} and Ce^{137}) on agricultural development and plant growth, behavior of Pu^{239}, Sr^{90}, and Cs^{137} in soils, reduction of radioactive uptake by plants, and decontamination of soil are considered. An extensive bibliography is included. (R.V.J.)

12359 RADIOACTIVE HEAT PRODUCTION IN ECLOGITE AND SOME ULTRAMAFIC ROCKS. G. R. Tilton and G. W. Reed (Universität, Bern; Carnegie Inst. of Washington, D. C.; and Argonne National Lab., Ill.). p.31-43 of "Earth Science and Meteoritics." New York, Interscience Publishers, 1963.

The concentration of uranium in five ultramafic rocks (peridotite) is taken to average 0.006 parts per million based on neutron activation and isotope dilution measurements. This value may be an upper limit. Eclogite nodules of probable mantle origin from tuff at Salt Lake Crater, Hawaiian Islands, were found to contain about ten times more uranium than the peridotites, but more than ten times less uranium than Hawaiian basalt. Potassium was also determined in these rocks. These results are discussed in terms of their bearing on the thermal history of the outer mantle of the earth. Heat production in the peridotites is too low to explain heat flow in oceanic areas if the outer mantle consisted solely of such rock. Rock of the chemical composition of peridotite might be a major constituent of the outer mantle in continental areas or of the deep mantle. The eclogites have heat production rates that are too low to account for the heat flow in the ocean floor if heat transfer takes place in the mantle solely by thermal conduction. Eclogite could provide a satisfactory heat source if convective transfer accompanies thermal conduction. It is doubtful that radiation plus conduction without convection would be sufficient. Rock two to three times more radioactive than the eclogites could provide sufficient heat flow in oceanic areas by thermal conduction alone. Reasons are given for believing that the eclogites provide a better guide to the proportions of the radioactive elements in the mantle than do chondritic meteorites. (auth)

12360 SOME RECENT RESEARCHES ON LEAD ISOTOPE ABUNDANCES. R. D. Russell (Univ. of British Columbia, Vancouver). p.44-73 of "Earth Science and Meteoritics." New York, Interscience Publishers, 1963.

Higher precision of measurement was obtained by comparing each unknown sample with a standard in a manner analogous to that widely used in the measurement of the isotopic abundances of the lighter elements. Thirty-one analyses from five mining areas in eastern Australia are quoted. Of these areas, three (Broken Hill, Captain's Flat, and Cobar) are most easily explained on the basis of development in a single system closed with respect to transfer of uranium, thorium, and lead. The uranium/lead ratios calculated for the source material for these leads differ by less than 0.2% ($0.0652 \leq V \leq 0.0653$) and the thorium/lead ratio, by less than 0.6% ($37.1 \leq W \leq 37.3$). Samples from southwest Finland gave similar values (V = 0.0652, W = 36.9). The assumption of a single-stage model is questionable in one of the remaining cases (Mt. Isa) and very doubtful in the other (Read Rosebery). The significance and importance of multi-stage models is discussed. A recent interpretation of Broken Hill anomalous leads is described. (auth)

12361 THE NATURAL DISTRIBUTION OF RADIOCARBON: MIXING RATES IN THE SEA AND RESIDENCE TIMES OF CARBON AND WATER. Harmon Craig (Univ. of California, La Jolla). p.103-14 of "Earth Science and Meteoritics." New York, Interscience Publishers, 1963.

The flux of radiocarbon into the deep sea is discussed, and it is shown that at least some of the radiocarbon is brought in by transfer from the mixed layer of the sea. A

"cyclic" model of the atmosphere-mixed layer-deep sea system is introduced as a second order approximation that allows direct exchange of carbon between the atmosphere and the exposed surface area of the deep sea reservoir. Residence times for mixing within the sea and between the atmosphere and sea are compared to those for the "chain" model used previously for discussing atmosphere–sea mixing. In the cyclic model the radiocarbon "age" of deep sea water is not the same as the oceanographic "displacement time" relative to water from the mixed layer. The relationships between the residence times of carbon and water, and the data required for the evaluation of these parameters, are discussed. (auth)

12362 ON THE INVESTIGATIONS OF GEOPHYSICAL PROCESSES USING COSMIC RAY PRODUCED RADIOACTIVITY. D. Lal (Tata Inst. of Fundamental Research, Bombay). p.115-42 of "Earth Science and Meteoritics." New York, Interscience Publishers, 1963.

The various aspects that are relevant to the practical applications of cosmic ray-produced radioisotopes in geophysical studies are reviewed. The potentialities of these natural tracers for the study of diverse geophysical processes and the present state of some of our knowledge based on their studies, are discussed. (auth)

12363 THE TRITIUM CONTENT OF ATMOSPHERIC HYDROGEN AND ATMOSPHERIC METHANE. F. Begemann (Max-Planck-Institut für Chemie, Mainz). p.169-87 of "Earth Science and Meteoritics." New York, Interscience Publishers, 1963.

Tritium is known to occur in three different chemical compounds in the terrestrial atmosphere; in water, in molecular hydrogen, and in methane. The data available until the beginning of 1962 on the tritium content of the free molecular hydrogen and atmospheric methane are discussed. While under natural conditions the tritium content of stratospheric moisture must be expected to be higher by about five orders of magnitude than that of tropospheric moisture, it is shown that for molecular hydrogen the tritium levels cannot be different by more than a factor of two. For methane no such estimate can be made as the source of the tritiated methane is not yet known definitely. Since the addition of man made tritium to the natural inventory, the tritium content of molecular hydrogen has been increased by more than a factor of twenty while the relative amount of HT is within a factor of five, the same as under natural conditions. Samples collected at Oberhausen (Germany) show no increase in the tritium content from the end of 1960 to February 1962. From 1953 to 1958 the tritium level in atmospheric methane collected in the southern hemisphere increased by a factor of ten; it has been constant in the northern hemisphere from 1958 to the beginning of 1962. It is shown that the increase in the southern hemisphere tritium level cannot be explained by assuming a point source injection of all the "excess" tritiated methane into the northern troposphere. It must rather have increased in a similar way as in the southern hemisphere. The close similarity of this hypothetical increase to that measured in molecular hydrogen points to a relationship between these two concentrations, the exact nature of which is not quite clear. (auth)

12364 TRITIUM IN RAINWATER. H. V. Buttlar (Technische Hochschule, Darmstadt, Ger.). p.188-206 of "Earth Science and Meteoritics." New York, Interscience Publishers, 1963.

The experimental techniques for the measurement of low-level activities of tritium are described. The sensitivities of the different methods are compared. On the basis of results of world-wide rainwater measurements, a discussion is given of the rate of production of tritium by cosmic radiation, wash-out time of the troposphere, and mixing mechanism between the stratosphere and the troposphere. Applications of tritium determinations to hydrologic problems are mentioned. (auth)

12365 COSMIC RAY PRODUCED Na^{22} AND Al^{26} ACTIVITIES IN CHONDRITES. M. M. Biswas, C. Mayer-Boericke, and W. Gentner (Max-Planck-Institut fur Kernphysik, Heidelberg). p.207-18 of "Earth Science and Meteoritics." New York, Interscience Publishers, 1963.

Cosmic ray-produced Al^{26} and Na^{22} activities in chondrites were studied by nondestructive $\gamma(511\ kev)-\gamma$ coincidence spectroscopy. The values of the Al^{26} specific activities of four hypersthene chondrite samples are nearly equal, and have a mean value of 0.061 Al^{26} e^+ decays/min·g. The Na^{22} specific activity of the Bruderheim chondrite was found to be 0.094 Na^{22} disintegr./min·g, in agreement with the results obtained by other authors using different methods. From the Na^{22} activity and the Ne^{22} content of our sample we have calculated an exposure age of 26×10^6 y for Bruderheim. (auth)

12366 ISOTOPIC AND CHEMICAL COMPOSITION OF SOME TERRESTRIAL NATURAL GASES. G. J. Wasserburg, E. Mazor, and R. E. Zartman (California Inst. of Tech., Pasadena). p.219-40 of "Earth Science and Meteoritics." New York, Interscience Publishers, 1963.

A variety of natural gases was analyzed for their content of argon, helium, hydrogen, carbon dioxide, methane, and heavier hydrocarbons, along with the isotopic compositions of argon and carbon. It is found that most natural gases, including samples from geothermal areas, have a $(He^4/A^{40})_{rad}$ ratio that is close to the production ratio in normal rocks. Glacial drift gases were found to have a distinctive chemistry and contain no detectable radiogenic argon. The observed atmospheric argon contents of all gases, including very high pressure sources, are found to be compatible with a simple solubility model. Using the measured ratios of $(He^4/A^{40})_{rad}$, a calculation of the mean life of He^4 in the atmosphere was made of $5 \times 10^5 \leq \tau\ He^4 \leq 2.5 \times 10^7$ years. (auth)

12367 IMPROVEMENTS IN OR RELATING TO RADIOACTIVE WELL LOGGING. (to Texaco Development Corp.). British Patent 948,310. Jan. 29, 1964. Priority date June 15, 1959, United States.

An improved method of neutron–gamma ray well logging is patented, in which the adverse effect of Cl on the detected γ-ray signal may be neutralized or the presence of oil or salt water in the earth formations along the well bore may be indicated. An elongated housing, which contains a neutron source and 2 radiation detectors, is passed through a bore hole. Neutrons and neutron-induced γ radiation are detected. In one aspect of the method, the effect of Cl on the neutron-induced γ-ray H-content signal is neutralized by γ-rays produced by intercepting thermal neutrons in the vicinity of one detector. In another aspect, one of the detected signals is indicative of the presence of H and Cl in the bore hole, and the other signal is indicative of only H. From these signals, quantitative information of the Cl and H content of the formation surrounding the bore hole may be obtained. Details of the apparatus and the various aspects of the method are presented. (M.P.G.)

Site Survey and Selection

12368 (NAA-SR-Memo-9235) NAA PROGRAM DESCRIPTION. AISITE—A REACTOR SITING CODE. R. A. Blaine (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 1963. Contract [AT(11-1)-Gen-8]. 47p.

The AISITE program determines siting criteria for reactors on the basis of the method described in TID-14844. The code varies any parameter, such as building leak rate, filter efficiency, clean-up rate, etc., and displays the exclusion area, low population boundary zone, and low population center distance as a function of that parameter. As a by-product, dose versus distance curves are obtained by organ and by isotope if desired. The theory is presented; and input, output, and operation are discussed. Sample input and output are included. (auth)

Techniques and Equipment

12369 RADIOCARBON DATING. W. F. Libby (Univ. of California, Los Angeles). Ann. Intern. Med., 59: 566-78(Oct. 1963).

Principles of the method, its development in the laboratory, and applications for dating archeologic artefacts are discussed. Theoretical aspects of C^{14} formation from cosmic radiation and calculations demonstrating the validity of using C^{14} content of animal and vegetable matter for age determination are outlined. It is concluded that the agreement between the predicted and observed assays of C^{14} is adequate evidence that the cosmic rays have indeed remained constant in intensity over many thousands of years, and that the mixing time, volume, and composition of the oceans have not changed either. On the assumption that organic matter, while it is alive, is in equilibrium with cosmic radiation; that is, all the C^{14} atoms that disintegrate in human bodies are replaced by the C^{14} contained in food, so that while alive, humans are part of a great pool that contains the cosmic ray-produced C^{14}. Cosmic produced C^{14} atoms are assimilated at just the rate that the C^{14} atoms in the body disappear to form N^{14}. At the time of death, however, the assimilation process stops abruptly. Development of measurement techniques is discussed, particularly the problems of shielding necessitated by low-activity samples. The C^{14} counting apparatus is described in detail and illustrated. After developing a technique that could measure natural carbon relatively inexpensively with the requisite accuracy, attempts were made to determine whether the assumption that the variation of radiocarbon production due to the variation of the cosmic rays with latitude, which is very strong, would be wiped out by the movement of the winds and the ocean currents in the 8000 yr lifetime of C^{14}. Evidence validating this assumption is discussed. Studies dating various artefacts and comparison with their known ages are extensively reviewed. The problems introduced by the release of fossil CO_2 into the atmosphere by combustion of coal and oil, resulting in dilution of biospheric C^{14}, and by C^{14} formation from neutron capture by N^{14} during nuclear explosions are discussed. Applications of C^{14} dating in geology, oceanography, meteorology, and archeology are reviewed. Construction of a portable radiocarbon dater, that will allow work in the field with the archeologists and geologists in obtaining dates and that is nearly as accurate as those obtained in the laboratory, is discussed. (BBB)

12370 THE USE OF RADIOACTIVE TRACERS IN HYDROLOGY AND HYDRAULICS. G. Grandclément (CEN, Grenoble, France). Eau, L, 50: 293-300(May 1963). (In French)

The properties and use of some tracers, including natural tritium, are discussed. Applications in subterranean hydrology and surface hydrology and hydraulics are considered, as well as the dating of waters by tritium content. (D.C.W.)

12371 FOSSIL RECORDS OF NUCLEAR FISSION. R. L. Fleischer, P. B. Price, and R. M. Walker (General Electric Research Lab., Schenectady, N. Y.). New Scientist, 21: 406-8(Feb. 13, 1964).

A discovery that some common minerals preserve the traces of natural fission of nuclei millions of years ago led to the establishment of a new means of dating rocks and other objects. Fossil tracks were discovered in the vicinity of a mica pleochroic halo. It was found that tracks in minerals can arise either from the spontaneous fission of a uranium atom or from collision of a cosmic ray with the nucleus of a heavy atom. Although spontaneous fission is rare, it does occur at a predictable rate, a factor that allows calculation of the time interval since solidification. Fossil track studies make possible the dating of very young minerals in a region of the time scale inaccessible to previously existing techniques. Accuracy of the method is good when results are compared with objects of known age. Tektite and impactite ages were measured by the method, and it was found that each of the impactites falls into one of the three tektite age groups, indicating a common origin. Future applications of fossil track dating will include the examination of meteorites. (H.M.G.)

12372 TRITIUM-HYDROLOGIC RESEARCH: SOME RESULTS OF THE U. S. GEOLOGICAL SURVEY RESEARCH PROGRAM. Charles W. Carlston (Geological Survey, Washington, D. C.). Science, 143: 804-6(Feb. 21, 1964).

In general tritium is of limited usefulness as a tool in hydrologic studies because the tritium content of ground water, as a result of radioactive decay, becomes too low to be detectable after about 50 years. Nevertheless, a unique study was made of the hydrologic cycle of small stream basins in Wisconsin and New Jersey on the basis of measurements relative to the peak of tritium fallout in the spring of 1958. The continental and the coastal basins received approximately the same tritium fallout. Approximately 30% went into ground-water storage, the remainder being exported as runoff and evapotranspiration. The mean residence time for ground-water recharge for the two basins was 45 and 30 days, respectively. (auth)

12373 OXYGEN–SILICON LOGGING METHOD UTILIZING EQUAL INTENSITY BUT DIFFERENT ENERGY NEUTRONS. Arthur H. Youmans (to Well Surveys, Inc.). U. S. Patent 3,120,612. Feb. 4, 1964. Filed Apr. 3, 1959.

A method is described for the content determination of strata from analytical curves for the particular strata. Neutrons of different energies and intensities are used to produce characteristic decay gammas in oxygen and silicon that are detected and along with depth data can determine the content of the strata. (R.E.U.)

12374 GEOPHYSICAL PROSPECTING METHOD BY MEANS OF NUCLEAR RADIATION. Gilbert Swift (to Well Surveys, Inc.). U. S. Patent 3,121,164. Feb. 11, 1964. Filed Oct. 27, 1958.

A method is described for radiometric well logging in

oil prospecting. Fast neutrons are used to obtain information characteristic of formations in the borehole. Differentiation of information from hydrogen and chlorine bombardment is achieved, thus making possible identification of salt water, fresh water, and oil zones. (R.E.U.)

12375 METHOD AND APPARATUS FOR CALIBRATION OF WELL LOGGING APPARATUS. Glenn E. Fryer (to Great Lakes Carbon Corp.). U. S. Patent 3,122,636. Feb. 25, 1964. Filed Dec. 23, 1958.

A calibration technique for a neutron well-logging system is described. A partial absorber replaces the shield between the source and detector. (R.E.U.)

12376 WELL PRODUCTION METHOD USING RADIOACTIVE TRACERS TO ESTABLISH TWO NULL POSITION. Stephen J. Limanek (to Texaco Development Corp.). U. S. Patent 3,123,708. Mar. 3, 1964. Filed Dec. 31, 1959.

A method is described for determining the amount and nature of the fluid that enters a borehole from any given vertical interval of a well. A radioactive tracer is used to determine the flow direction. The method yields a productivity profile log of a production formation of a well. (R.E.U.)

12377 DENSITY MEASUREMENT OF BOREHOLE FLUIDS USING AXIALLY SPACED RADIOACTIVE SOURCE AND DETECTOR MEANS. Richard L. Caldwell and Robert F. Sippel (to Socony Mobil Oil Co., Inc.). U. S. Patent 3,123,709. Mar. 3, 1964. Filed Mar. 10, 1960.

An apparatus is described for measuring the density of borehole fluids at various depths. Gamma transmission is utilized. (R.E.U.)

Thorium and Uranium Minerals

12378 STUDIES ON THE DETERMINATION OF THE RADIOACTIVE MATERIALS CONTENT OF NATURAL WATERS. Zoltán Dézsi (Inst. of Experimental Physics, Debrecen, Hungary). Fiz. Szemle, 13: 298-304(Oct. 1963). (In Hungarian)

Presence of radioactive materials found in natural waters may be due to natural radioactive substances, contamination by fallout, or to the waste effluents from reactors. Determination of the natural radioactivity is of great economic importance because it may be an indicator of usable U deposits; however, care must be taken in interpretation of the data. The high sensitivity of the fluorometric method makes it possible to detect 10^{-5} to 10^{-10} of U. Integrating pulsed ionization chambers were used for determining the Ra and Rn concentrations in waters. The results of analytical determinations in Rumania and Hungary are reviewed. Although a large body of numerical data is available, no generally valid laws could be developed, although it can be stated that within a given geological formation, the distribution of U and Ra follows the logarithmic Gaussian law. There is no equilibrium between the radioactive materials dissolved in the water. U concentrations of the order of 10 γ/liter could not be correlated with the presence of U-rich ores in the surrounding area. (TTT)

HEALTH AND SAFETY

Refer also to abstracts 11634, 11643, 11951, 12347, 12817, and 12847.

12379 (AD-403714) FOOD SERVICE PROCEDURES IN FALLOUT SHELTERS. (Cornell Univ., Ithaca, N. Y. School of Hotel Administration). Apr. 30, 1963. Contract OCS-OS-62-49. 204p.

A study was made of the management problems involved in the procurement, storage, preparation, and service of water and food in fallout shelters having a capacity of 50 or more occupants. Particular attention was given to the composition, quality, quantity, and variety of foods capable of being easily stored, prepared, and apportioned under emergency conditions at minimum cost. The Civil Defense rations provided for public shelters are compared with those provided for semi-public shelters where these rations are supplemented with other foods. Other phases of shelter management considered include space allotment for occupants and food services, ventilation, temperature, sanitation, and odor control. (C.H.)

12380 (AD-404511) THE FALLOUT PROTECTION BOOKLET: I. A REPORT OF PUBLIC ATTITUDES TOWARD AND INFORMATION ABOUT CIVIL DEFENSE. David K. Berlo, Erwin P. Bettinghaus, Dan Costley, and Robert Van Dam (Michigan State Univ., East Lansing. Coll. of Communication Arts). Apr. 1963. Contract OCD-OS-62-19. 127p.

A study was made of the impact of the "Fallout Protection" booklet which was published by OCD in December 1961. While collecting data specific to that objective, other useful information relevant to public information about and attitudes toward civil defense was collected. Data are presented on the accuracy of public knowledge about nuclear attack and civil defense, the favorability of public attitudes toward civil defense measures, public perceptions of the threat of nuclear war and the personal dangers represented by nuclear attack, the relative effectiveness of various shelter inducements and inducement agents, and the level of public exposure to shelter information. Analyses of attitudinal and demographic correlates of shelter knowledge, belief, and plans are also presented. (auth)

12381 (AD-404512) THE FALLOUT PROTECTION BOOKLET: II. A COMPARISON AMONG FOUR GROUPS OF DIFFERING LEVELS OF INTEREST IN SHELTER CONSTRUCTION. David K. Berlo (Michigan State Univ., East Lansing. Coll. of Communication Arts). Apr. 1963. Contract OCD-OS-62-19. 22p.

A study was made of the impact of the Fallout Protection booklet which was published by OCD in December 1961. While collecting data specific to that objective, other useful information relevent to public information about and attitudes toward civil defense was collected. Data are presented from an analysis of respondents, who were classified into four levels of interest with respect to constructing family shelters. (C.H.)

12382 (AD-411787) EMERGENCY HEALTH PROBLEMS STUDY. VOLUME I. Final Report. W. T. Herzog (Research Triangle Inst., Durham, N. C.). July 31, 1963. Contract OCD-OS-62-250. 84p.

The peacetime health status of the population (based on the U. S. Public Health Service National Health Survey) and the estimated range of complications due to shelter living were evaluated. Rough estimates suggest that medical care and public health measures could add a number of survivors equal to 1 to 2% of the total preattack population during a single two-week period under ideal conditions. Postattack medical care of casualties would not seriously compete with measures directed toward health maintenance of the general population, except for consumable medical supplies. Because casualty care and health maintenance of noncasualties are capable of adding comparable numbers of survivors during the shelter period (a maximum of 2% of the preattack population for either type of emphasis), it is concluded that both approaches should be emphasized. The available data on chronic, noncommunicable diseases are sufficient to allow more quantitative stockpile planning of medical items for these conditions in shelters. Further research will be necessary before this is true for communicable diseases, because of the complexity of disease spread during shelter confinement. A method for optimizing the allocation of drugs for support of noncommunicable chronic and acute conditions to shelters in a stockpiling program is suggested and illustrated by an example. (auth)

12383 (AD-413416) ENVIRONMENTAL CONTROL SYSTEMS FOR CLOSED UNDERGROUND SHELTERS. T. R. Charanian, A. J. Glueckert, R. G. Barile, and J. D. Zeff (General American Transportation Corp. MRD Div., Niles, Ill.). Apr. 1963. Contract OCD-OS-62-56. 141p. (MR-1190-50)

An investigation and cost analyses were made of atmosphere control techniques for use in closed underground fallout shelters. Internally located, self-contained environmental control systems are required for shelter atmosphere control whenever the presence of nearby outside fires precludes the supply of outside air to the shelter. Environmental control systems which were evaluated included all conceivable types of oxygen supply, carbon dioxide and toxic constituent removal, and temperature and humidity control. The project was divided into four principal categories: study of man's physiological environmental requirements, engineering evaluation and analysis of all conceivable systems, experimental investigation of candidate systems, and application study for selection of the appropriate system for particular shelter types. (auth)

12384 (AERE-R-4485) A METHOD OF TESTING THE EFFICIENCY OF A RESPIRATOR USING A HALOGENATED HYDROCARBON TEST GAS. D. J. Morgan (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Jan. 1964. 8p.

A method of determining the protection afforded by a respirator, by measuring the leakage of dichlorodifluoromethane, was developed to determine whether facepiece leakage is of the same order of magnitude for both gases and particles. Although the method is inherently less sensitive and less robust than the salt test, a comparison of the two methods on a limited number of subjects showed that there is no significant difference in facepiece leakage for gases or particles. (C.H.)

12385 (NP-13568) CASUALTIES FROM NUCLEAR WEAPONS. A MANUAL FOR EMERGENCY HEALTH SERVICES. (Canada. Dept. of National Health and Welfare, Ottawa). 1963. 144p.

Information is summarized for the use of members of health professions on the prevention and management of casualties resulting from the explosion of a multi-megaton nuclear weapon. The effects of blast, shock waves, thermal radiation from the explosion, fires, trauma caused by missiles, ionizing radiations, early and late fallout, and communicable disease on populations are considered. It is postulated that during the first post-attack week traumatic and thermal casualties will present the major problem; from the second through the fourth weeks acute radiation syndrome will develop in unshielded populations; and after the fourth week communicable diseases will become a serious threat to the disorganized community. The protection afforded by various types of shelters, monitoring methods, methods for the decontamination of personnel and equipment, methods for the survey of food and water supplies, and hospital facilities and medical services likely to be available in Canada are discussed. (C.H.)

12386 (NP-13599) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 2, No. 1. (Canada. Dept. of National Health and Welfare, Ottawa). Jan. 1964. 69p.

In English and French.

Data are presented on radioactivity due to fallout in samples of air, precipitation, surface waters, and milk collected at various stations throughout Canada during 1963. Data are included from measurements of I^{131}, Sr^{89}, Sr^{90}, and Cs^{137} in whole and powdered milk samples. The radioactivity in the environs of Atomic Energy of Canada Limited, Chalk River, was attributed to natural sources and fallout from nuclear weapons tests rather than to the operation of the reactors. (C.H.)

12387 (TO-B-63-25) THE EFFECT OF RADIATION REFLECTED FROM THE CEILING ON THE DOSE RATE WITHIN STRUCTURES. John F. Batter and Joseph D. Velletri (Technical Operations, Inc., Burlington, Mass.). Apr. 1963. Contract OCD-OS-62-14. 50p. (AD-413552)

An experiment was designed to estimate the effect of ceiling-scattered radiation on the dose rate within a structure. Measurements of the contributions as a function of the solid angle subtended by the ceiling as viewed from a detector are compared to results calculated using albedo data. The total magnitude of ceiling-shine radiation is found to be similar to that of sky-shine radiation. (auth)

12388 (UR-636) AN INVESTIGATION OF THE INTERACTIONS THAT OCCUR BETWEEN RADIONUCLIDES AND AEROSOLS IN THE RESPIRABLE SIZE RANGE. Douglas Kenneth Craig (Rochester, N. Y. Univ. Atomic Energy Project). Nov. 11, 1963. Contract W-7401-eng-49. 259p.

It has been reported in the literature that radioactive nuclides are usually subject to rapid and irreversible adsorption at surfaces. Aerosols, whether pre-existing in the atmosphere or generated in a nuclear incident, represent such surfaces and it is to be expected that radionuclides that escape into the environment will become attached to them. The importance of the relation between adsorbed activity and aerosol particle size is discussed. Most of the reported work in this field has been concerned with the decay products of radon and thoron, and the conclusions from these studies are contradictory. A labeled iron oxide aerosol was allowed to interact with radionuclides consisting of molecular sodium iodide with specific activities of from 0.15 to 15 Mc I^{131}/mg NaI. The Goetz Aerosol Spectrometer was used to characterize the adsorption of NaI molecules onto the aerosol as a function of particle size. Relative radionuclide-aerosol concentrations were varied from 3×10^2 to 3×10^5 molecules per particle and mean interaction times by a factor of about 2.5. Although considerable quantities of the radionuclide did become attached to the aerosol, the adsorption process was not irreversible. Variation of the experimental conditions over the above range did not significantly affect the results. The adsorbed activity was proportional to function $D(I)^Z$, where D(I) is the aerosol diameter and $2 \leq Z \leq 3$ over the approximate size range $0.06 \leq D(I) \leq 0.65\ \mu$ and possibly up to particle diameters as large as $1.2\ \mu$, the inference being that adsorbed activity would be proportional to the true surface area under equilibrium conditions. (auth)

12389 RADIATION PROTECTION AND DECONTAMINATION IN ISOTOPE LABORATORIES. Ulrich O. Schanze. Acta Radiol. (N.S.), 1: 484-96(Dec. 1963). (In German)

An accident trolley is described that contains everything needed if an accident with radioactive materials occurs. Instructions for decontamination are given and measures to be taken after mishaps with open isotopes are recommended. Cleansing and treatment of laundry that is contaminated with radioactive materials are discussed and an active laundry is described. (auth)

12390 RADIATION PROTECTION PROBLEMS FOR MAN IN SPACE. E. S. Matusevich and S. G. Tsypin. At. Energ. (USSR), 15: 499-504(Dec. 1963). (In Russian)

On the basis of the terrestrial radiation belts and the observed outbursts of high-energy particles by solar flares, it is estimated that an unprotected man in the center of the inner belt, at a distance of 3000 to 4000 km from the Earth would be exposed to about 100 rem/hour; at the height of a severe flare, that person would receive a radiation exceeding several times the lethal dose. The galactic cosmic radiation causes a dose rate of 30 to 100 rem/year; shielding against it would reach several tens of grams per cm^2 of the living quarters of the space ship, since this radiation acts continuously. The cosmic radiation consists primarily of charged nuclei of H and of the heavier elements, up to Zn at a flux of (2.3 ± 0.1) particles/sec cm^2 or 1830 particles/m^2 sec sterad. About 80% of the galactic radiation consists of protons; 18 to 19% of α particles, and 1 to 2% of particles with $Z \geq 3$. The charged particles of the solar flares consist primarily of protons and to a lesser extent of He nuclei and considerably fewer nuclei with $6 \leq Z \leq 9$. The internal radiation belt contains protons and electrons; the external belt mostly protons. To enable the crew of the spaceship to pass through these belts while providing sufficient protection against solar flares, shields weighing several tons are considered necessary; for long interplanetary flights this shielding could reach a weight of 10 tons. (TTT)

12391 THE MONITORING OF THE RADIOACTIVITY OF WATERS. PROBLEMS POSED BY THE MEASUREMENT AND THE USE OF THE RESULTS. A. Grauby and P. Raimbault. Eau, L, 50: 307-13(May 1963). (In French)

Standards, quantities, and techniques in the measurement of activity are discussed, and apparatus and stations for monitoring the activity of water for consumption and of radioactive effluents are discribed. (D.C.W.)

12392 SKIN CONTAMINATION BY RADIOACTIVE ISOTOPES. II. RABBIT SKIN CONTAMINATION BY ^{90}Sr–^{90}Y AND ^{32}P. Yoshiki Wadachi, Shingo Tashiro, Yūzō Tajima, and Tetsuo Hiyama (Japan Atomic Energy Research Inst., Tokyo and Japan Atomic Power Co., Tokyo). Nippon Genshiryoku Gakkaishi, 5: 994-6(Dec. 1963).

An investigation of the mechanism of skin contamination was carried out on a living rabbit skin. The rabbit skin was contaminated with carrier free Sr^{90}–Y^{90} or P^{32}. Conse-

quently, the adhered contamination of epidermis or the permeated contamination of dermal (permeated contamination) was obtained with the same result as that of pig skin. In regard to $Sr^{90}-Y^{90}$ and P^{32}, the adhered contamination increased steeply within 30 min after contamination and then increased gradually with an increase of contaminating time. The results also showed that according to pH, $Sr^{90}-Y^{90}$ indicated a large difference but P^{32} did not indicate such difference in the adhered contamination. On the other hand, the definite permeated contamination was obtained after long contamination without the case of acidic P^{32}, although there was no regularity in the tendency to the permeated contamination. Particularly, Y^{90} contributed considerably to the adhered and permeated contamination, if the contaminating solution of $Sr^{90}-Y^{90}$ was alkaline. The results indicate an early decontamination, within 30 min after contamination, is of great advantage to decontamination of human skin. (auth)

12393 THE CONTROL OF RADIOACTIVITY IN WATERS AND SOIL. O. Jaag (Eidgenoessische Technische Hochschule, Zurich). Oncologia, 16: (3) 230-44(1963). (In German)

The establishment of research atomic reactors in Switzerland and conduction of atomic bomb tests in other countries has necessitated extensive organization of facilities to ensure the control of radioactivity in surface waters, rivers, lakes, reservoirs, and ground waters. For instance, the concentration of radioactivity permitted in the Aare river at the Wuerlingen reactor is $1/20$ of the value for drinking water (1000 pC/l). Very close attention is given to concentrations of the deleterious radioisotopes, such as $Sr^{90}-Y^{90}$, Cs^{137}, and I^{131}. Air and water contamination studies showed concentration peaks in summer 1957, fall 1958, and fall 1961 resulting from atomic bomb tests. Water contaminations remained below dangerous levels. Water plants and animals can markedly accumulate the activity, though, and plankton from the Aare river had activities of 10,000 to 15,000 pC/kg dry weight when the water concentration was 4 to 5 pC/l, and 40,000 to 200,000 pC/kg when the water concentration was 6 to 8 pC/l. In grasses the activity level (1961) was 14 to 20 pC/g dry weight and 200 pC/g ash. The Sr^{90} concentration was over 4 pC/g ash. The Sr^{90} concentration in the top 5 cm of soil (air dried) in Wuerlingen was ~170 pC/kg and 50 to 80 pC/kg in the next 10 cm below. In Zuerich the Sr^{90} concentration in the upper layer was ~110 pC/kg. In order to purify contaminated waters, ion exchangers, precipitants, adsorbents, and evaporation procedures are used. Mixed ion-exchange beds are extremely effective for removal of many radioisotopes, but many adsorbents and precipitants are much less useful. Peat from the Jura region removes over 99% of Sr^{90} and 90 to 95% of mixed radioisotopes from cistern water. This water contains as much as 20 to 50 pC/l, but only 3 pC/l of this is Sr^{90}, so that it is still drinkable. A comparatively simple glass filtration apparatus can be used with peat for purification of cistern water. (BBB)

12394 IMPROVED RADIATION PROTECTION DURING THE USE OF SEALED RADIOACTIVE SOURCES BY MEANS OF A TROLLEY ON RAILS AND A LEAD SHIELDED TREATMENT TABLE. Rolf Dietze (Kreiskrankenanstalte, Gotha, Ger.). Radiobiol. Radiotherap. (Berlin), 2: 31-9 (1961). (In German)

A trolley is used for transportation of radioactive sources from storage or preparation table to operating table. The trolley moves on rails at table height. These extend through an outer wall for the entire length of a radioisotope storage room, preparation room, and operating room. The trolley container is shielded below and on the three inward sides by five cm of Pb. The container dimensions are $20 \times 15 \times 15$ cm. Above there is a $10 \times 10 \times 10$-cm space for loading of large sources and shaped forms. The container is moved by electric motors which are deactivated by an automatic disconnect at each terminus. The trolley is steered in both directions by push-buttons from each of the three rooms. Radioactive sources are easily transported by this means, and multiple sources can be packed in layers within the trolley, in order of planned use. The trolley is brought to the treatment table only for the time actually required. The operating table is designed especially for gynecological Ra and Co^{60} treatments, with three in thick Pb shields below and at each side. A chest shield is emplaced at the foot of the table, leaving the head and extremities of the physician free, but exposed to the radiation. In practice the arrangement reduces the gonad dose to the physician to $1/8$, and the lower body exposure is reduced to $1/12$ or $1/16$, of the unshielded value. Typical radiation dose values for an 80-mg Ra implantation are to head, chest, abdomen, and knee 0.04, 0.01, 0.002, and 0.001 mr/sec, respectively. The number of Ra implantations is limited, by the exposure of the hands to radiation, to 42 for the physician, but to only 8 for the nursing assistant. (BBB)

12395 INTRODUCTION TO MEDICAL-SURGICAL EMERGENCIES IN CASE OF NUCLEAR EXPLOSION. Luis Benitez Soto. Rev. Sanidad Mil. (Mex.), 17: 151-3 (Mar.-Apr. 1963). (In Spanish)

A comparison is made between the effects of nuclear and conventional (TNT) explosions, the types of casualties resulting in each case, and the specific effects of blast, heat and radiation from nuclear detonations. The projected effects on human populations are discussed with reference to the Hiroshima experience. (BBB)

12396 PREVENTIVE ASPECTS IN NUCLEAR ATTACK. Eduardo Echeverria (Hospital Central Militar, Mexico City). Rev. Sanidad Mil. (Mex.), 17: 154-65(Mar.-Apr. 1963). (In Spanish)

A description of protective measures to be taken in a nuclear attack is given and the terminology defined. The immediate effects of a 5-megaton explosion are described, as well as the distribution of the radiation which follows. (BBB)

12397 GIGIENA TRUDA PRI RABOTE S TORIEM. (Industrial Health in Handling Thorium). N. Yu. Tarasenko. Moscow, Gosatomizdat, 1963. 88p.

A review is given of the physico-chemical and radioactive characteristics of thorium and its distribution in nature. Biological effects, toxicity, and permissible doses of thorium and its decay products are discussed as well as prophylaxis and protective measures. 106 references. (R.V.J.)

12398 RADIOLOGICAL HEALTH DATA [MONTHLY REPORT], VOLUME IV, NUMBER 9. (Public Health Service, Washington, D. C.). Sept. 1963. 52p. $0.50(GPO). (RHD-Vol. IV, No.9)

Data are presented on fission product radioactivity in samples of airborne particulates and precipitation collected throughout the U.S. and Canada during May 1963 and at Pan American sampling stations during Nov. 1962; radionuclides in institutional diet samples collected throughout the U.S. during January, February, and March 1963; the content of Sr^{89}, Sr^{90}, Cs^{137}, I^{131}, and Ba^{140} in pasteurized milk samples collected throughout the U.S. during May 1963 and

in Canada during April 1963; the radioactivity in raw surface waters sampled at 126 stations throughout the U.S. during 1963; and in vivo measurements of I^{131} in children's thyroids. Results are included from a survey of radioactivity in the environs of Union Carbide Nuclear Co., Oak Ridge, Tenn. and Paducah, Ky., during 1962. Data are summarized for 3 low-yield underground nuclear detonations announced during August 1963. Separate abstracts were prepared for 3 sections of this report. (C.H.)

12399 TRI-CITY DIET STUDY, NOVEMBER 1962–JANUARY 1963. Joseph Rivera (Health and Safety Lab., AEC). Radiol. Health Data, 4: No. 9, 446-8(Sept. 1963).

Estimates are presented of the Sr^{90} content of the average diet of residents of New York City, San Francisco, and Chicago from Nov. 1962 through Jan. 1963. Selected foods representing 19 categories purchased in the 3 cities were analyzed for Sr^{90}. Results indicate that milk continues to be the predominant source of Sr^{90} in the diet. Data are included from estimates on the daily intake of Sr^{90} in total diets in the three cities during 1960, 1961, and 1962. (C.H.)

12400 TEMPORAL AND GEOGRAPHICAL DISTRIBUTIONS OF STRONTIUM-90 AND CESIUM-137 IN FOOD (1960-1962). Edwin P. Laug (Dept. of Health, Education, and Welfare, Washington, D. C.). Radiol. Health Data, 4: No. 9, 448-54(Sept. 1963).

Since 1960 the Food and Drug Administration has collected and analyzed individual foods to determine their content of Sr^{90} and Cs^{137} resulting from fallout. Ninety-two different varieties of domestic and imported foods, including baby foods, were analyzed. Data are summarized for 1960, 1961, and 1962. No foods were found whose daily consumption would result in the suggested daily limits of intake of Sr^{90} or Cs^{137}. Preliminary findings indicate that a variety of mechanical processing operations are effective in reducing the Sr^{90} content of raw foods. (C.H.)

12401 RADIOLOGICAL HEALTH DATA [MONTHLY REPORT], VOLUME V, NUMBER 1. (Public Health Service, Washington, D. C.). Jan. 1964. 44p. $0.50(GPO). RHD-Vol. 5, No. 1.

Data are presented on levels of radioactivity due to fallout in samples of airborne particulates, precipitation, milk, surface water, and drinking water collected throughout the U.S. during 1963. Data are included from air-monitoring networks in Canada, Mexico, Pan America, and along the 80th meridian, and measurements of Sr^{90} in milk and drinking water collected at various sampling stations throughout the U.S. Results are included from a preliminary survey of dairy cattle feeding practices. Data on environmental levels of radioactivity at Hanford Atomic Products Operation, Richland, Wash., during 1962 are summarized. Two low-yield underground nuclear detonations at the Nevada Test Site were reported during Dec. 1963. A separate abstract was prepared for one section of this report. (C.H.)

12402 SOME OVER-ALL ASPECTS OF STRONTIUM–CALCIUM DISCRIMINATION. C. L. Comar (Cornell Univ., Ithaca, N. Y.). p.405-17 of "The Transfer of Calcium and Strontium Across Biological Membranes." New York, Academic Press, 1963.

Data are summarized from a number of studies on the metabolism of Sr. Emphasis is placed on the behavior of Ca and Sr in biological systems, the relation between levels of Sr^{90} in the environment that will cause long-time radiation exposure and genetic effects in human populations, the effects of short-term exposures to Sr^{90}, the contribution of Sr^{90} to radioactive contamination of food chains, and the development of remedial measures against Sr^{90} uptake by man. (C.H.)

12403 GIGIENICHESKIE VOPROSY PRI PODZEMNOI RAZRABOTKE URANOVYKH RUD. (Problems of Industrial Health in Underground Mining of Uranium Ores). A. V. Bykhovskii. Moscow, Medgiz, 1963. 332p.

Industrial hygiene in uranium mining is analyzed, and characteristics of uranium minerals and deposits are reviewed. Toxicology of uranium, radium, and radon aerosols are discussed as well as the radioactive contamination of work clothing. Means for radiation protection, sanitary-hygienic practices, equipment and techniques for ventilation, and decontamination measures are discussed. Reduction of radon, isolation of areas not in operation, decontamination of mine water, and prophylactic measures are evaluated and discussed. An extensive reference list is included. (R.V.J.)

12404 ZASHCHITNYE POKRYTIYA V ATOMNOI TEKHNIKE. (Protective Coatings in Nuclear Technology). S. M. Gorodinskii and V. B. Tikhomirov. Moscow, Gosatomizdat, 1963. 184p.

Twenty-one articles are presented on the properties of polymers for use as protective coatings. (R.V.J.)

12405 LEGAL LIABILITY FOR RADIATION INJURIES RESULTING FROM EMERGENCIES IN MEDICINE, RESEARCH AND INDUSTRY. Edward H. Forgotson (Department of Health, Education, and Welfare, Washington, D. C.). 9p. (CONF-277-3)

From Symposium on Radiation Emergencies in Medicine, Research, and Industry, Chicago, Dec. 1963.

Basic liability problems encountered in radiation emergencies where negligence law prevails and medical causation are discussed. It is stressed that everyone concerned with liability problems in radiation emergency situations, as in all radiation injury cases, must keep everything in its proper perspective. (P.C.H.)

12406 CONTAINER FOR STORING AND TRANSPORTING DEPLETED FUEL ELEMENTS OF NUCLEAR REACTORS. Herbert Menze and Rudolf Schulten (to Brown, Boveri & Cie. AG). German Patent 1,154,884. Sept. 26, 1963. Filed Nov. 30, 1960.

The container described is filled with an organic liquid medium that has a melting point between 20 and 40°C. The organic medium, e.g. diphenyl or paraffin, has good heat conducting properties when liquid. (Gmelin Inst)

12407 CONTAINER FOR TRANSPORTING THERMALLY HOT INTENSELY RADIOACTIVE MATERIAL. John W. Allen (to Stanray Corp.). U. S. Patent 3,119,933. Jan. 28, 1964. Filed May 3, 1960.

A container is described with an inner and outer shell of high-strength high-thermal-conductivity material with radiation-absorbing material interposed between the shells. Web sections are provided in the absorber for thermal conductance from the inner to the outer shell. (R.E.U.)

12408 RADIOACTIVE SOURCE STORAGE CONTAINER WITH ELONGATED FLEXIBLE MEANS FOR REMOVING SOURCES FROM THE CONTAINER. Robert J. Prest (to Technical Operations, Inc.). U. S. Patent 3,120,613. Feb. 4, 1964. Filed Feb. 13, 1956.

A device for transporting and changing sources is described that comprises an elongated flexible carrier for the radioactive material with a unitary shielding body, a changer head mounted on the body with connectors for tubular conduits, and two channels within the body closed at one end and curved toward the open end so as to obstruct any straight path. (R.E.U.)

12409 MEANS FOR SELECTIVELY MONITORING RADIOACTIVITY IN CONDUITS IN CLOSE ARRAY. Robert G.

McGrath (to Westinghouse Electric Corp.). U. S. Patent 3,121,789. Feb. 18, 1964. Filed Jan. 23, 1959.

A radiation monitor system is described for continuous operation for a large number of fluid streams. Only one detector is required as the conduits pass juxtaposed in close proximity in a circular disposition and the detector selectively faces them. The system is applicable to monitoring many fluid streams for leakage of radioactivity. (R.E.U.)

INSTRUMENTATION

General

12410 (AD-406377) SOIL DENSITY STUDIES IN CONNECTION WITH DETECTION OF UNDERGROUND NUCLEAR EXPLOSIONS, PART I. NUCLEAR TECHNIQUES. Dwight L. Gravitte and Leonard M. Young. PART II. THERMAL TECHNIQUES, PACKRAT, HARDHAT AND GNOME EVENTS. Stanley L. Carts and Leonard M. Young. Final Technical Report. (Army Engineer Research and Development Labs., Fort Belvoir, Va.). Nov. 1, 1962. 50p.

Nuclear techniques: The continuous-reading Qualicon 502 bulk density gauge cannot be used effectively to detect density differences in the soil because of extreme sensitivity to height variations and soil micro-relief. The P-22 surface density gauge is suitable for detecting soil density differences. Effects of normal variations in local soil texture, structure, and moisture content (weather conditions) will present serious problems in the use of any soil-density measuring instrumentation for detection of underground explosion areas and may invalidate their use. Thermal techniques: Although extreme background temperature contrasts may present thermal imaging problems, satisfactory imaging of a test area can be accomplished with good image detail during both day and night observations. The Packrat blast site was detectable on Thermograph T-2 thermal images during both day and night. (auth)

12411 (AEET/Anal./18) THE PERFORMANCE OF UVISPEK SPECTROPHOTOMETER IN THE REGION 220 mμ TO 500 mμ. B. N. Srinivasan (India. Atomic Energy Establishment, Trombay). 1963. 13p.

The performance, that is the accuracy and reproducibility of the Uvispek spectrophotometer, was determined employing a standard alkaline solution of potassium chromate. The standard deviation values obtained are compared with the available data obtained on several Cary and Beckman instruments in the region 220 to 500 mμ. The spectrum of alkaline potassium chromate shows a new absorption peak at 210 mμ having $\log_{10}\epsilon = 4.10$. (auth)

12412 (AFCRL-63-753) RADIATION HARDENING THE STANDING-WAVE IMPEDANCE PROBE. Scientific Report No. 1. L. C. Howlett, J. P. Evans, and K. D. Baker (Utah. Univ., Salt Lake City. Upper Air Research Lab.). Dec. 19, 1963. Contract AF19(628)-447. 55p.

The radiation hardening process for the Standing Wave Impedance Probe is discussed. Included in this process is the selection of radiation resistant components on the basis of a literature search, gamma radiation testing, and neutron radiation testing. Indications were that many of the semiconductors, resistors, and insulators used in the original Impedance Probe were unreliable in a radiation environment such as encountered in the nuclear powered Agena satellite 626. This environment is expected to consist of a yearly radiation dose of 5×10^{12} n/cm^2 and 5×10^7 gamma rads. The choice of radiation resistant components based on the literature search findings was substantiated by a gamma radiation test at 7.5×10^4 rad/hr and a neutron radiation test supplying a total dose of 4×10^{13} n/cm^2. (auth)

12413 (CONF-187-54) A HIGH-SPEED READOUT FOR MULTI-CHANNEL PULSE-HEIGHT ANALYZERS. W. W. Wilkins, L. E. Fite, and R. E. Wainerdi (Texas. Agricultural and Mechanical Univ., College Station. Engineering Experiment Station. Activation Analysis Research Lab.). [1962]. Contract AT(40-1)-2671-1. 5p.

From American Nuclear Society Meeting, New York, Nov. 1963.

In computer-coupled automated activation analysis such as in the Mark II system, conventional methods of data readout impose a serious restriction on the minimum handling time per sample. A data coupler for operating between the data accumulation system and the computer tape unit was developed which contributes nothing to the handling time per sample, does not distort the data, and prepares the data for direct computer entry. In addition to activation analysis, the coupler may be used to obtain successive spectra separated in time by 0.16 sec in the study of short-lived isotopes. (D.L.C.)

12414 (GA/Phys/63-4) ATMOSPHERIC DENSITY MEASUREMENT BY USE OF RADIOISOTOPE TECHNIQUES (thesis). Richard Eskridge (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio). Aug. 1963. 84p. (AD-418989)

Interactions of radiation particles and rays with air molecules are investigated as means of measuring air density. These interactions include transmission and scattering of alpha particles, beta particles, and gamma rays. Only the scattering of beta particles and gamma-rays are found to be suitable for use in density measurement. Environment effects on the accuracy of a radioisotope density gage are examined. The shock layer, and possibly cosmic radiation background, are the sources of the largest errors. Electric field, magnetic field, and boundary layer effects are believed to be small. The overall error in density measurement, induced by the environment, is estimated to be between ten and fifteen percent. The results of experiments, with the use of the scattering of beta particles, to measure air density are reported. Usable data is obtained in the 100,000 to 270,000 foot altitude range. Promethium-147 and strontium-90 yttrium-90 are used as beta particle sources, and the responses of the two sources are compared. (auth)

12415 (GNE/Phys/63-14) INVESTIGATION OF AN X-RAY-BEAM DENSITY PROBE (thesis). Robert B. Morrow, Jr. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio). Aug. 1963. 89p. (AD-418563)

A method for measuring the localized average density of a gas or plasma by directing a narrow x-ray beam from an x-ray analysis unit through the gas and counting the induced fluorescent characteristic x rays of the gas was investigated. Plots of the count rate of the characteristic x rays, detected by a flow-type gas proportional counter, versus the argon density were used for calibration. A differential pulse height analyzer was used to selectively count only x rays corresponding to the argon K fluorescence x-rays. A linear relation was consistently observed between count rate and argon density for a range of argon densities from 10^{17} to 2×10^{18} atoms/cc. Count rates experienced with a tungsten target x-ray tube ranged between 4800 and 8000 cpm, corresponding to densities of 10^{17} and 2×10^{18} atoms/cc, respectively. Use of a copper target x-ray tube reduced these count rates to 1200 and 3700 cpm, respectively. The x-ray beam density probe

investigation of the density as a function of position in an abnormal glow discharge revealed no significant variations. However, using the probe to measure the density in a glow discharge in the region up to one centimeter from the cathode indicated about 25% reduction in the argon density from no glow conditions. The temperatures calculated from measured average densities and the recorded pressures exceeded 1000°K for applied voltages from 640 to 800 volts at a constant argon pressure of 415 microns. (auth)

12416 (HW-79621) THE MEASUREMENT OF METAL TEMPERATURE BY AN ELECTROMAGNETIC INDUCTION METHOD. H. L. Libby (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 12, 1963. Contract AT(45-1)-1350. 41p.

The basic principles of inductive thermometry are outlined and their relationship to the principles of electromagnetic methods of nondestructive testing are described. Measured values of the impedance of long and short solenoids with conducting cores are shown and compared with calculated values for the infinitely long solenoid. It is shown that the impedance loci for varying core conductivity for the short solenoid differs from that of the calculated loci for the infinitely long coil in that the ratio of maximum resistance change to maximum reactance change decreases as the solenoid is shortened. Measured impedance loci are also shown for a large flat coil and a small flat inductive thermometer sensing coil when placed adjacent to the surfaces of common materials. The impedance loci are shown and analyzed in a manner to aid in illustrating the principles of inductive thermometry and to serve as aids in the future design of sensing coils and inductive thermometer circuitry. An application of the principles of inductive thermometry is described in which fabricated nonbonds between the aluminum jacket and uranium core of a nuclear fuel element were detected. This was accomplished by heating the surface of the fuel element and sensing the rise in temperature of the surface over the fabricated nonbonds. Circular nonbonds having $\frac{1}{4}$, $\frac{3}{8}$, and $\frac{1}{2}$ in. diameters were detected. The major difficulty encountered with the inductive thermometer was the undesired effect resulting from temperature change of the sensing coil. This effect on the sensing coil can cause error in calibration and decrease the ability of the circuit to discriminate changes in spacing between the sensing coil assembly and the test specimen surface. It is concluded that the induction method of measuring temperatures of metals can be successfully applied to sense surface temperatures of metals. The method promises to fulfill a need where fast response is needed or where physical contact with the test surface is undesirable or impractical. Special effectiveness has been shown in the high speed scanning of a metal surface. (auth)

12417 (JINR-P-1475) YADERNYI MAGNITOMETR DLYA IZMERENIYA SIL'NO NEODNORODNYKH MAGNITNYKH POLEI. (A Nuclear Magnetometer for Measuring the Strongly Inhomogeneous Magnetic Fields). D. P. Vasilevskaya, L. V. Vasil'ev, and Yu. N. Denisov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1963. 14p.

A nuclear magnetometer that is used for precision measurements of magnetic fields with gradients up to 1000–3500 oersted/cm is described. The results of the calculations of the field built up by two types of the current quadrupoles are given. These quadrupoles form the compensating gradient in the sample. (auth)

12418 (K-T-552) ERROR DETERMINATION IN HIGH TEMPERATURE THERMOCOUPLE MEASUREMENTS. G. K. Moeller, B. R. Bronfin, and Paul Whitmarsh (Massachusetts Inst. of Tech., Oak Ridge, Tenn. Engineering Practice School). Nov. 30, 1960. Contract [W-7405-eng-26]. 38p.

A theoretical method has been developed for estimating errors in high temperature thermocouple measurements due to partial shorting of the ceramic insulation, and has been programmed for the IBM-704 digital computer. The thermocouple was divided into incremental lumped parameter networks. The network equations were solved with the aid of the computer to find the value of the emf which would be measured if a given temperature profile existed along the thermocouple. By comparing this value with the hot junction emf, an error may be assigned to that particular set of conditions. The program was tested with a set of typical parameters and the results obtained agreed with those of a hand calculation. Fair predictions of error can be obtained by using this program if the input data are reliable. The program can be enlarged and refined to consider more complicated geometries and minor effects not treated in the present work. (auth)

12419 (NP-13562) A REVIEW OF DUOPLASMATRON-, PIG-, AND RF-ION SOURCES. Rijnhuizen Report 63-11. W. Huizenga (Stichting Voor Fundamenteel Onderzoek der Materie. Instituut Voor Plasma-Fysica, Jutphaas, Netherlands). July 1963. 15p.

The construction of duoplasmatron, PIG, and r-f ion sources is described, together with their working principles. Recent data on maximum extractable ion current and beam composition are included. 41 references. (auth)

12420 (SLAC-24) FIRST- AND SECOND-ORDER BEAM OPTICS OF A CURVED, INCLINED MAGNETIC FIELD BOUNDARY IN THE IMPULSE APPROXIMATION. R. H. Helm (Stanford Univ., Calif. Stanford Linear Accelerator Center). Nov. 1963. Contract AT(04-3)-400. 20p.

The second-order calculation of the magnetic boundary of a wedge-type magnetic spectrometer is extended to include off-midplane rays. (auth)

12421 A MASS SPECTROMETER TO DETERMINE SUBNORMAL CONCENTRATIONS OF DEUTERIUM IN HYDROGEN. M. Pascalau and D. Ioanoviciu (Inst. of Atomic Physics, Cluj). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 14: 763-8(1963). (In Rumanian)

The construction of a mass spectrometer having an electron-bombardment ion source and a magnetic analyzer with 60° sector is described. The deuterium concentration in the range from 10 to 5000 ppm can be determined with this spectrometer with a precision of 1.4% for the natural concentration. (tr-auth)

12422 EFFECTS OF MAGNETIC FIELD NONUNIFORMITIES ON THE PERFORMANCE OF DOUBLE-FOCUSING MASS SPECTROMETERS. L. A. Cambey, J. H. Ormrod, and R. C. Barber (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 42: 103-12(Jan. 1964).

The effects of magnetic field nonuniformities on the focusing properties of the three types of magnetic field sectors commonly employed in mass spectrometers and spectrographs are discussed. Two types of magnetic field nonuniformities are considered: those in which the vertical component of the magnetic field, B_z, varies along the central ion path (azimuthal nonuniformities) and those in which B_z is a function of the displacement in the direction normal to the central ion path (radial nonuniformities).

To facilitate the interpretation of results, the ions entering the magnetic field are assumed to have the velocity dispersion required to form a velocity focus at the position of the direction focus (i.e., to give a double focus), if the magnetic field were uniform. (auth)

12423 A QUANTITATIVE STUDY OF SCATTERING PHENOMENA IN AN ELECTROMAGNETIC SEPARATOR. M. Menat (Faculté des Sciences, Orsay, France). Can. J. Phys., 42: 164-92(Jan. 1964).

A series of recent experiments has shown that the elastic scattering of a directed ion beam by residual gas is one of the dominant factors causing contamination in an electromagnetic mass separator. Thus phenomenon is treated numerically, based on geometrical considerations and on an appropriate and reliable interaction potential between the ions and the residual gas molecules. The result is a relation $i_c^+/\mathcal{I}^+ = 4n_r\sigma_0(M/\Delta M)^{n-1}\Delta x T(\phi_0)$, expressing the fractional contamination as a function of: the residual gas molecule concentration n_r, the fractional mass difference $\Delta M/M$, the collector slit width Δx, the configuration factor $T(\phi_0)$, and constants (σ_0 and n) that appear in the expression for the differential cross section. The reciprocal value $\mathcal{I}^+/i_c^+$ imposes an upper limit to the enhancement factor. By performing the various integrations in a different sequence, a general expression for the transmission from source to collector is obtained. The influence of losses caused by inelastic scattering can be easily incorporated. For elements with a mass number of about 200, scattered by air, and for an accelerating voltage of about 30 kv, this expression takes the form: $\mathcal{I}^+/\mathcal{I}_0^+ \simeq \exp[-n_r L\{7.5 \times 10^{-18}(L/\Delta x)^{0.69} + 4 \times 10^{-16}\}]$, where L is the total ion path length in the separator. (auth)

12424 THE NEUTRON HYGROMETER. NUCLEAR APPLICATION IN THE DETERMINATION OF WATER CONTENT OF SOIL. J. Marcesse. Eau, L, 50: 287-92 (May 1963). (In French)

A hygrometer for determining the water content of soil by fast neutron thermalization is described. (D.C.W.)

12425 THERMOCOUPLES WITH ELECTRODES OF REFRACTORY CARBIDES FOR USE UP TO 3000°C. A. D. Panasyuk and G. V. Samsonov (Inst. of Cermets and Special Alloys, Academy of Sciences, Ukrainian SSR). High Temp., 1: 116-19(July-Aug. 1963).

The preparation of NbC with graphite and Nb and Zr carbide electrodes for use up to 3000°C is described. The NbC–ZrC couple has some advantages over the NbC–C; in particular, its response is more stable, especially after homogenization firing, which gives rise to a region of solid solution of the carbides. Also, graphite rods show marked changes in thermoelectric behavior at 2700–3000°C, presumably on account of very slow, continuing graphitization, which is usually not completed during manufacture. The design of a thermocouple in which the current leads are joined to the electrodes by screws or via copper rings deposited electrolytically on the ends is given. (P.C.H.)

12426 SOME RESULTS OF THE USE OF TRANSITION-METAL CARBIDES AS THERMIONIC EMITTERS IN ELECTRONIC DEVICES. S. P. Rakitin, V. S. Fomenko, and V. N. Paderno (Inst. of Cermets and Special Alloys, Academy of Sciences, Ukrainian SSR). High Temp., 1: 124-7 (July-Aug. 1963).

A method is described for the preparation of tablets of zirconium, hafnium, niobium, and tantalum carbides, and some results are presented of the use of these carbides as thermionic cathodes in the electric gun of a dismountable electronic device. Considerable emission current densities (up to 20 A/cm^2) were obtained, as the result of which the use of such carbides as thermionic cathodes in electronic devices is regarded as promising. (auth)

12427 CONVERSION OF FLUOROSCOPIC IMAGES BY X-RAY IMAGE INTENSIFIER TUBES AND APPLICATIONS. L. F. Guyot (Compagnie Francaise Thomson Houston, S. A., Paris). p.130-42 of "The Reduction of Patient Dose by Diagnostic Radiologic Instrumentation." Springfield, Ill., Charles C. Thomas Publishers, 1964.

The performance of 6- and 9-in. x-ray image intensifier tubes for the conversion of fluoroscopic images is discussed. Applications in direct viewing, cinerecording, and televised viewing are discussed. (C.H.)

12428 TEKHNIKA FORMIROVANIYA VYSOKOVOL'-TNYKH NANOSEKYNDNYKH IMPUL'SOV. (Techniques for Producing High Voltage Nanosecond Pulses). G. A. Vorob'ev and G. A. Mesyats. Moscow, Gosatomizdat, 1963. 167p.

A systematic compilation of data is presented on techniques for producing high-voltage nanosecond pulses. Descriptions are given of devices for both production and conversion. An analysis is made of processes taking place in sparks, considering Weizel and Rompl theories, streamer theory, and transition processes. 150 references. (R.V.J.)

12429 A COLD CATHODE DISCHARGE GAUGE FOR ULTRA HIGH VACUUM USE. J. R. Young and F. P. Hession (General Electric Co., Schenectady, N. Y.). 11p. (CONF-209-22)

From American Vacuum Society Meeting, Boston, Oct. 1963.

A cold cathode gage that utilizes the Penning-type discharge was constructed that is shown to be capable of measuring pressure between 10^{-3} and 10^{-14} torr. This gage has a sensitivity near 1 amp/torr. A trigger filament enables instant starting even at pressures below 10^{-10} torr. This gage provides several advantages over an ionization gage for measuring pressure. The advantages are: (1) increase in sensitivity, (2) no hot filaments to interact with active gases during normal operation, the trigger filament is heated only during starting, (3) ability to measure pressure below the x-ray limit of most ionization gages, (4) much less outgassing during operation, and (5) does not interact with active gases to produce impurities. A cold cathode discharge gage was also constructed with an electron multiplier that may be capable of measuring a pressure of 10^{-21} torr. (auth)

12430 SIGNALS FOR TRANSFER FUNCTION MEASUREMENTS IN NONLINEAR SYSTEMS. Elias P. Gyftopoulos and Richard J. Hooper (Massachusetts Inst. of Tech., Cambridge). 15p. (CONF-332-11)

From Symposium on Noise Analysis in Nuclear Systems, Gainesville, Fla., Nov. 1963.

The synthesis of test signals for the measurement of dynamic characteristics of nonlinear systems described by a functional expansion is discussed. The output of a nonlinear system can be expanded into an infinite sum of functionals of the input, which are multi-dimensional convolution integrals depending on the input and upon a kernel that is characteristic of the system. (R.E.U.)

12431 IMPROVEMENTS IN OR RELATING TO SAMPLING APPARATUS. Fred Jones and John Noel Money (to United Kingdom Atomic Energy Authority). British Patent 947,509. Jan. 22, 1964. Filed July 25, 1961.

An apparatus for taking representative samples of liquid

flow along large channels is patented. A flow divider consisting of a set of weirs extends across the channel. Additional flow dividers are arranged in series, so that the weirs of one flow divider collect behind them then flow over a specific weir in the preceding flow divider. There is a continual fall in level from the first to the last flow divider. The flow over a particular weir in the last flow divider is collected for analysis. Baffles upstream of the flow dividers provide streamlined flow and ensure a representative sample at the collector. The apparatus is especially designed for collecting samples from the flow from storage reservoirs for irradiated reactor fuel elements, where the flow may be of the order of 500,000 gal/day. (M.P.G.)

12432 IMPROVEMENTS IN OR RELATING TO SPECTROSCOPIC APPARATUS. (to Baird-Atomic, Inc.). British Patent 947,712. Jan. 29, 1964. Priority date June 1, 1959, United States.

A spectrometer for determining the relative proportions of U^{235}, U^{236}, and U^{238} in reactor fuel is patented. The characteristic radiation from an electrically excited sample passes through an entrance slit and a diffraction grating. A solid wedge of transparent material is located in the path of the U-235, -236, and -238 spectral lines from the grating. The wedge has a forward transverse face of minute width and a pair of oblique faces diverging from the grating. The wedge is positioned to transmit the image of the U-236 spectral line through the transverse face and to reflect the U-235 and -238 images from the oblique faces. Three photocells receive the 3 separate images from the transverse and oblique faces, and an automatic servo system maintains the relative positions of the entrance slit, grating, and wedge. Details of the optical and electrical systems are presented. (M.P.G.)

12433 ELECTROMAGNETIC COIL. Pierre Hubert and Andre Bariaud (Communaute Europeenne de l'Energie Atomique (EURATOM)). British Patent 947,850. Jan. 29, 1964. Priority date Nov. 3, 1961, France.

The design of an electromagnetic coil for the production of intense magnetic fields is patented. The magnetic field is made very symmetrical by suppressing parasitic fields near the electrical conductors, and mechanical stresses in the coil are equalized. The coil is wound on an insulating cylindrical tube, which has an annulus of larger diameter than the tube at one end. A metal ring is located on each side of the insulating annulus. Many electrical conductors connected in parallel start from one metal ring, pass radially inward to the insulating tube, wind helically over the outer surface of the tube, at the end of the tube away from the annulus pass radially to the inside surface of the tube, wind helically along the inside of the tube, and then pass radially outward to the second metal ring. The pitch of the inside and outside helices are of opposite sense. The entire assembly is rigidly enclosed by insulating material. (M.P.G.)

12434 IMPROVEMENTS IN TELEVISION CAMERAS. Donald Jackson (to Pye Ltd.). British Patent 948,003. Jan. 29, 1964. Filed Oct. 26, 1959.

A small television camera or an attachment for a camera for use in confined spaces such as in reactors and to view objects to one side of the camera is patented. A mirror is mounted in front of the camera lens at an angle to the lens axis, to reflect light into the lens from an object not in front of the camera. A light source to illuminate the object is mounted behind the mirror, so that the mirror prevents light from the source from falling directly on the lens. The angle of the mirror and the direction of the light source can be remotely adjusted. (M.P.G.)

12435 IMPROVEMENTS IN OR RELATING TO PLUG AND SOCKET TYPE ELECTRICAL CONNECTORS. Peter Edward Clarke (to Atomic Power Constructions Ltd.). British Patent 949,232. Feb. 12, 1964. Filed May 10, [1961].

A plug and socket type electrical connector was developed that has, on one portion, at least one rigid contact member, and on the other portion, for each rigid contact member, a cooperating resilient contact member. One contact member encircles the other when the portions are fully engaged and makes contact with it at spaced points at which the resilient contact is stressed when the members are in contact, and in which both portions have surfaces spaced from the contact members and such that, when the portions move together to engage the contact members, the surfaces cooperate to align those members prior to their engagement. (M.C.G.)

12436 VOLUMETRIC DISPENSING DEVICE WITH RADIOACTIVE CONTROL MEANS. Ulrich Bauder and Otto Barthelmess (to Firma Fr. Hesser Maschinenfabrik AG). U. S. Patent 3,120,607. Feb. 4, 1964. Priority date Jan. 12, 1959, Germany.

An apparatus is described for continuous measurement of the density of material flowing through a conduit to a dispensing machine. A source-detector system is described that automatically regulates the volume of material allowed to pass through the conduit. (R.E.U.)

12437 X-RAY APPARATUS FOR MEASURING PAPER WEB DENSITY. Carl A. Vossberg. U. S. Patent 3,121,168. Feb. 11, 1964. Filed Oct. 20, 1960.

A noncontacting thickness gage is described that is independent of composition changes in the test specimen. The contents of sealed cans may be measured volumetrically or on a mass basis independently of can lid thickness. Means are provided for measuring the moisture content and density of a paper web or the contents of sealed cans using an x-ray tube with cyclic anode voltage for x rays of different energies and a photomultiplier detection system. (R.E.U.)

12438 VIRTUAL-EARTH AMPLIFIERS. Donald Harrison (to United Kingdom Atomic Energy Authority). U. S. Patent 3,121,199. Feb. 11, 1964. Priority date Nov. 4, 1959, Great Britain.

A d-c virtual-earth amplifier for use as a differentiating amplifier in reactor period meters is described. The circuitry provides a smoothing time-constant that is large for fixed input currents and is reduced during changes in input current. (R.E.U.)

12439 APPARATUS FOR FOCUSING A LINE TYPE ION BEAM ON A MASS SPECTROMETER ANALYZER. Jens Geerk and Ludolf Jenckel (to Atlas-Werke AG). U. S. Patent 3,122,631. Feb. 25, 1964. Priority date Feb. 5, 1960, Germany.

The focusing of an ion beam on a magnetic field analyzer of a mass spectrometer is described. (R.E.U.)

12440 FRICTION-FREE BALANCE. Neill J. Carson, Jr., Herbert W. Ostrander, and Carl N. Munter (to U. S. Atomic Energy Commission). U. S. Patent 3,123,165. Mar. 3, 1964.

A weighing device having a load-supporting vertical shaft buoyed up by mutually repellant magnets is described. The shaft is aligned by an air bearing and has an air gage to sense vertical displacement caused by weights placed on the top end of the shaft. (AEC)

Radiation Detection

Refer also to abstract 11941.

12441 (AD-408469) PRODUCTION ENGINEERING AND PROTOTYPE MANUFACTURE OF THE AERIAL SURVEY METER CD V-781AX. Final Report. (Radio Corp. of America. Aerospace Communications and Controls Div., Burlington, Mass.). Jan. 21, 1963. Contract OCD-OS-62-167. 56p.

Production engineering of the Aerial Survey Meter CD V-781 AX was performed, based on a prototype developed by the Oak Ridge National Laboratories of the Atomic Energy Commission. Six pre-production equipments incorporating the results of the production engineering effort were built. Operational and environmental tests were performed, and an equipment specification was written. Recommendations regarding accessory equipment, test results, and the V-781 AX equipment specification are given. (auth)

12442 (AD-412461) PORTABLE SURVEY METER FOR MEASUREMENT OF X-RAY HAZARDS ASSOCIATED WITH RADAR (X-RAY HAZARD METER). C. Christianson, L. Mackay, and E. Duffy (Naval Material Lab., Brooklyn). June 28, 1963. 35p.

Investigations of various techniques and methods for measurement of pulsed x radiation from radar established the scintillation technique to be the most feasible. Research on various scintillation phosphors resulted in the development of a unique dual-phosphor scintillation detector. Utilizing an RCA 6199 PM tube and the dual phosphor (wafers of Pilot B and lucite loaded with Ag-activated ZnS) energy independence for effective energies of 20 kev to 1.3 Mev is achieved to within about 15%. Four ranges (5, 50, 500, and 5000 mr/hr) are provided to measure pulsed x ray doses from radars. For a radar (1 μsec pulse width, 200 pps repetition rate) the instrument can measure peak x ray dose rates of 25, 250, 2500, and 25,000 r/hr without saturation. The instrument is insensitive to microwave radiation in the X band region up to 50 milliwatts/cm^2 and to magnetic fields up to one gauss at 30 Kc/s. The probe is provided with arc-over protection. A prototype model is described. (auth)

12443 (AD-413449) RESEARCH INVESTIGATION OF p-i-n ELECTRON JUNCTION DETECTORS. Interim Engineering Report No. 2, May 11, 1963–August 11, 1963. (Hughes Aircraft Co. Hughes Research Labs., Malibu, Calif.). Contract NObsr 89169. 17p.

For comparison of the response of lithium-drifted p-i-n silicon, junction detectors to beta-ray sources with extrapolation chamber measurements of the surface absorbed dose rate, thick sources containing Tl^{204} were utilized in carefully specified geometries. Dose rate measurements were made using sources with areas of 10.0 and 1.04 cm^2. Detector open-circuit voltage measurements were made for the 1.04-cm^2 area source, using a number of thin-window p-i-n junction detectors. Comparison to extrapolation chamber measurements shows a linear correlation between open-circuit voltage and surface absorbed dose rate up to rates as high as 400 rad/hr for the geometries studied. (auth)

12444 (AD-415810) FILM DETECTOR FOR A NEUTRON SPECTROMETER (thesis). Darrell Grant Martin (Texas. Univ., Austin). June 1963. 53p.

The photographic method of detecting thermal neutrons for possible application to the field of neutron spectroscopy is investigated. The emphasis throughout is to present sufficient data to establish the relative merits of the detector as opposed to other detection devices used in this field. (auth)

12445 (BNL-7656) DESIGN OF He^3-FILLED FAST PROPORTIONAL COUNTERS. J. L. Friedes and R. E. Chrien (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract [AT(30-2)-Gen-16]. 21p. (CONF-22-31)

From American Physical Society 1963 Annual Meeting, New York, Jan. 1963.

Electron drift velocity measurements have been made on helium, helium–CO_2, and helium–CH_4 mixtures in order to determine the optimum design parameters for He^3-filled proportional counters. It is shown that small (<1 in. dia) counters with neutron-detecting efficiencies of greater than 1% at 1 kev and with jitter times of less than 1 μsec are practical. Calculated and measured jitter times for several counters are compared. (auth)

12446 (BNL-7768) BROOKHAVEN FSD SYSTEM STATUS— FIRST 1000 EVENTS. P. L. Connolly, P. V. C. Hough, R. C. Strand, and W. M. Thompson (Brookhaven National Lab., Upton, N. Y.). Nov. 6, 1963. Contract [AT(30-2)-Gen-16]. 6p.

The performance of the system is discussed. A measurement rate of about 70 events/hr was attained, and a two-pass rejection ratio of about 10% appears feasible. Also the possibility has arisen that the 7094 can take over MANUAL FILTER, which is now inhibiting the count rate. An error in range measurements also appeared. Further studies on bubble density measurement and other topics are also discussed. (D.C.W.)

12447 (BNL-7769) PROGRESS REPORT ON HPD BUBBLE DENSITY MEASUREMENTS. Y. Oren and R. C. Strand (Brookhaven National Lab., Upton, N. Y.). Jan. 15, 1964. Contract [AT(30-2)-Gen-16]. 5p.

Bubble density measurements for meson (π^-) events at 1.5 Bev/c were compared with density predictions. For tracks that were not very dense, the measured density was within 20–30% of the predicted density. In 9 of the 117 events considered, the experimental and theoretical densities disagreed completely. However, an unambiguous choice was possible in the other events. (D.C.W.)

12448 (CERN-63-37(p.43-75)) THE SPARK CHAMBER NEUTRINO EXPERIMENT AT CERN. H. Faissner (European Organization for Nuclear Research, Geneva).

Theoretical considerations, physical problems, and their experimental implications involved in the use of a spark chamber in the CERN neutrino experiment are discussed. (C.E.S.)

12449 (CERN-63-37(p.77-82)) THE USE OF THE BUBBLE CHAMBER IN THE NEUTRINO EXPERIMENT. D. C. Cundy (European Organization for Nuclear Research, Geneva).

The design of the bubble chamber and the investigation of all sources of background for a neutrino experiment are discussed. The event rate, analysis and measurement, the distinguishability of pions and muons, the interpretation of events, and vector boson events are also considered. (C.E.S.)

12450 (CERN-63-37(p.131-43)) THE MAGNETIC SPARK CHAMBER. Guy von Dardel (European Organization for Nuclear Research, Geneva).

The advantages of incorporating a magnetic field in the spark chamber in the CERN neutrino experiment are discussed. (C.E.S.)

12451 (CERN-63-37(p.145-62)) ON THE SPARK FORMATION IN THE SPARK CHAMBER. S. Fukui (European Organization for Nuclear Research, Geneva).

The spark formation in the spark chamber is discussed on the assumption that the streamer theory is applicable in the pulsed field across a relatively high pressure gas. (C.E.S.)

12452 (CERN-63-37(p.215-17)) PRELIMINARY DATA FROM THE NEUTRINO PRE-RUN (JUNE 13–16, 1963). (European Organization for Nuclear Research, Geneva).

The experimental lay-out, beam structure, and bubble and spark chamber photographs are illustrated for a preliminary run of the neutrino experiment. Equipment performance and scanning measurements are briefly discussed. (C.E.S.)

12453 (CONF-340-15) He^3 NEUTRON SPECTROMETER USING PULSE RISE-TIME DISCRIMINATION. A. Sayres and M. Coppola (Columbia Univ., New York). [1961]. Contract [AT(30-1)-1808]. 42p.

From American Physical Society 1963 Autumn Meeting, Chicago, Oct. 1963.

A He^3 filled proportional counter can be used for neutron detection in the range 100 kev to 8 Mev by using the $He^3(n,p)T$ reaction. The major limitation as a neutron spectrometer is that the He^3 recoil distribution, arising from the elastic scattering of the higher energy neutrons present, masks the $He^3(n,p)T$ peaks due to lower energy neutron groups. Since a He^3 recoil and a proton of equal energies have different specific ionizations and therefore different ranges in the counter filling, one therefore has a means to distinguish between pulses from the $He^3(n,p)T$ and $He^3(n,n)He^3$ reactions. For appropriate operating conditions the rise-time of the pulses for these two events will be different. By converting this rise-time to a pulse height and only accepting pulses with long rise-times (which correspond to protons from the $He^3(n,p)T$ reaction), one now has a neutron spectrometer useful in an energy interval between the maximum neutron energy present and that energy for which the proton range equals the range of the maximum energy He^3 recoil. Spectra of monoenergetic neutrons obtained with a He^3 filled proportional counter and the pulse rise-time discrimination are presented to illustrate the energy range over which this detector may be used as a neutron spectrometer. Under typical operating conditions, spectra of the $Mg^{24}(d,n)Al^{25}$, $Si^{28}(d,n)P^{29}$, $S^{32}(d,n)Cl^{33}$ reactions were obtained to illustrate the performance of the spectrometer. (auth)

12454 (CRRD-1172) LATENT IMAGE FADING IN DUPONT TYPE 555 PERSONNEL MONITORING FILM AT CHALK RIVER. G. B. Knight and C. R. Hoffmann (Atomic Energy of Canada Ltd., Chalk River, Ont.). Sept. 1963. 7p. (AECL-1872)

DuPont type 555 films enclosed in the new AECL Photobadge were irradiated and stored at temperatures and relative humidities ranging from 35 to 85°F, and 35 to 75% for one and two-week periods. It was concluded that the effect of latent image fading was small compared with the errors normally encountered in relating film optical density to exposure, and in any case not greater than 10%. (auth)

12455 (DP-856) A SENSITIVE RADIATION MONITOR FOR A LARGE LABORATORY AREA. LeConte Cathey and Richard A. Moyer (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Nov. 1963. Contract AT(07-2)-1. 11p.

An instrument has been built to survey releases of radioactivity within the 22-acre enclosure of the Savannah River Laboratory. The device consists of a 2-in.-diameter × 2-in. sodium iodide scintillation crystal with associated detector counting and recording circuits which provide a permanent record of radioactivity movements within the Laboratory area. The monitor detects signals of 6.9 $\mu r/hr$ from a 0.48-curie cobalt-60 source located 265 ft away. (auth)

12456 (EIR-59) THE TIME-ENERGY RESPONSE OF NaI AND CsI CRYSTALS TO 14-Mev NEUTRONS. G. D. Hickman and F. Hegedues (Switzerland. Eidgenössisches Institut für Reaktorforschung, Würenlingen). Oct. 1963. 40p.

Pulsed neutron and activation measurements were performed on Bi- and Pb-shielded NaI and CsI crystals. The major neutron induced reactions in the shields and crystals were identified and analyzed. Intensity ratio factors for the various long terms (1 sec–4 hours) activities, as a function of the counting energy interval, were obtained. An expression is given whereby these ratio factors can be used to calculate the buildup of these activities in a pulsed experiment. The values obtained for the ratio of $\sigma^{23}_{Na}(n,\alpha)$ to $\sigma^{23}_{Na}(n,\rho)$ ranged between 2.1 ± 0.4 and 4.4 ± 0.9. These values are in fair agreement with the value of 3.3 ± 0.8 obtained by Bormann. Pulsed measurements on Bi and Pb indicate the possibility of constructing directional fast neutron Bi and Pb counters. (auth)

12457 (EUR-491.e) A NANOSECOND TIME CODER WITH GREAT ANALYSIS RANGE FOR TIME-OF-FLIGHT EXPERIMENTS. P. Klopf, H. Meyer, W. Stueber, and H. Verelst (European Atomic Energy Community. Central Nuclear Measurements Bureau, Geel, Belgium and European Atomic Energy Community. Joint Nuclear Research Center, Ispra, Italy). 1963. 20p.

A nanosecond time coder for on- and off-line time-of-flight analysis is described. The coder features a smallest channel width of 1 nsec and a maximum possible channel number for a time accuracy of one channel of more than 2^{13} channels. A regulation system was developed to increase the latter value to 2^{18}. An overall differential accuracy of ±0.15 nsec was attained for input pulses with a risetime of up to 20 nsec. (auth)

12458 (GEAP-4386) THE FEASIBILITY OF USING IN-CORE ION CHAMBERS TO COVER THE COMPLETE REACTOR NEUTRON FLUX RANGE FROM STARTUP TO FULL POWER. IN-CORE INSTRUMENTATION DEVELMENT PROGRAM. Quarterly Progress Report, June–September 1963. R. A. DuBridge (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Oct. 1963. Contract AT(04-3)-189. 138p.

The feasibility of covering the complete reactor neutron flux startup range fron $10^3 - 5 \times 10^{13}$ nv by using in-core chambers is determined. The counting mode of operation will be used at low neutron fluxes and the root mean square voltage fluctuation mode will be used at high neutron flux levels. Experiments were made utilizing various ion chambers, gases, gas pressures, voltages, and cables to measure sensitivities and ranges operating in the counting and RMS voltage modes. Theoretical discussions are presented showing how the RMS voltage is related to individual pulse at both amplifier input and output. Noise is also compared at amplifier output so that the optimum bandwidth can be selected. Spectral shifts with changes in applied voltage causing signal variations were examined and can be eliminated by appropriate selection of amplifier bandwidth. In the counting mode, all experiments were conducted with

unterminated cable. The chamber was designed with geometry, gas, and pressure to completely stop fission fragments in the gas and hence maximize the charge generated in the chamber. Cables were selected to minimize capacity. Various gases, pressures, and voltages were used to determine that an optimum design was achieved. (N.W.R.)

12459 (HW-78268) AN ALPHA SCINTILLATION TESTER FOR URANIUM SURFACE CONTAMINATION OF N-REACTOR FUEL. C. N. Jackson, Jr. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 1963. Contract AT(45-1)-1350. 20p.

A nondestructive tester and some of its applications in measuring 10 to 100 μg of uranium surface contamination on unirradiated, low enrichment, uranium fuel elements are described. The fuel elements will be used in N-Reactor, a dual-purpose, power generating reactor being constructed at Hanford. The tester uses a zinc sulfide scintillation system which detects the natural alpha decay of uranium. It can test 118 in^2 of surface at one time in a counting period of 10 min with a sensitivity of 13×10^{-9} g/cm^2. Various trade-offs between statistical reliability and counting time (6 min or less) are worked out for a go, no-go type of testing. The tester's use in measuring the contamination on production fuel elements and in pinpointing the manufacturing operations that caused contamination are described. (auth)

12460 (JINR-P-1489) METOD VYCHISLENIYA GEOMETRICHESKOI EFFEKTIVNOSTI REGISTRATSII SOBYTII V PUZYR'KOVOI KAMERE. (A Method for Calculating the Geometrical Detection Efficiency of Events in a Bubble Chamber). V. E. Vishnevskii, Yuan-ta'si Tu, G. I. Kopylov, et al. (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy and Joint Inst. for Nuclear Research, Dubna, U.S.S.R.). 1964. 20p.

A method is proposed for calculating the geometrical detection efficiency of events. It makes full use of all the information about the conditions for the occurrence of the process under investigation. It is shown that a further accumulation of information about the events under study decreases the fluctuation in their weights. The method is illustrated by the examples of calculating the geometrical detection efficiency for $V^0p \rightarrow V^0p$ scattering, for V^0 particles produced either as single or in pairs in a n-prong star. (auth)

12461 (ORNL-TM-786) CALIBRATION OF RADIATION MONITORS FOR PROCESS WASTE WATER. R. L. Shipp (Oak Ridge National Lab., Tenn.). Feb. 12, 1964. Contract [W-7405-eng-26]. 10p.

Two configurations of radiation detectors, used at ORNL for monitoring branch lines of the process waste-water sewer for radioactive contamination, were calibrated to obtain beta- and gamma-energy response curves. These curves, and published data on decay schemes, were used to calculate the response of the detectors to several isotopes. The detectors and calibration procedure are described, and the calibration data are analyzed. (auth)

12462 (PAN-437/IA) DETERMINATION OF THE LONG COUNTER EFFICIENCY FOR NEUTRONS FROM THE Ra–Be SOURCE AND FROM THE $T(d,n)He^4$ REACTION. E. Rurarz and D. Grabowski (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). May 1963. 19p.

A neutron monitor of Hanson-McKibben type has been constructed. Its efficiency was determined for neutrons from the Ra–Be source and from the $T(d,n)He^4$ reaction. The neutron flux was determined by the method of copper foil activation. After subtraction of the background of the scattered neutrons, the efficiency of the long counter was found to be independent of the source-monitor distance and amounted to $E_{Ra-Be} = 0.15 \pm 0.04\%$ and $E_{T(d,n)} = 0.17 \pm 0.03\%$. (auth)

12463 (PAN-442/I,I-A) MECHANICZNY SELEKTOR NEUTRONOW REZONANSOWYCH "AGNIESZKA" (I). (Resonance Neutron Mechanical Selector "Agnieszka." [Part] I). A. Graffstein (Graffshtein) and Z. Wilhelmi (Vil'gel'mi) (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). June 1963. 23p.

Technical assumptions concerning the construction of a resonance neutron velocity selector are discussed; and the experiments that prompted the design of the fast chopper AGNIESZKA are described. (auth)

12464 (PAN-443/I,IA) MECHANICZNY SELEKTOR NEUTRONOW REZONANSOWYCH "AGNIESZKA" (II). (Resonance Neutron Mechanical Selector "Agnieszka." [Part] II). A. Graffstein (Graffshtein) and Z. Wilhelmi (Vil'gel'mi) (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). June 1963. 32p.

The resonance neutron velocity selector built and put into operation in the Institute of Nuclear Research in Warsaw is described. Some operational results are given. (auth)

12465 (RADC-TDR-63-29) ANALYSIS OF PULSED X-RADIATION GENERATED BY HIGH POWERED ELECTRONIC EQUIPMENT. Final Report. James A. Wall (Controls for Radiation, Inc., Cambridge, Mass.). June 18, 1963. Contract AF30(602)-2493. 119p. (AD-412820)

A scintillation spectrometer was tested for its ability to measure the spectra of pulsed x radiation. It was found to be a useful instrument for the measurement of the spatial energy distribution of x rays generated by high-powered electronic equipment. A theoretical study was conducted in an attempt to obtain a means of predicting the spatial energy distribution of x-rays generated by electrons with energies between 10 and 500 kv incident on a thick copper target. At least qualitative agreement was obtained between the theoretical and experimental results for x rays generated by electrons with energies up to 74.7 kv. Different x-ray detectors were tested for their response to pulsed x rays and r-f radiation. Geiger-Mueller counters were found useful only for the measurement of pulsed x rays of low peak intensity, but were unaffected by r-f radiation. (auth)

12466 (UCLA-520(p.75-9)) BIOPHYSICS. (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology).

The construction is reported of a high quantum hydraulic scanning mechanism for use in the demonstration of brain tumors after the administration of a radioactive material. Techniques were perfected for the use of a transistorized 400-channel multichannel analyzer in conjunction with a Coulter counter for very rapid determinations of cell-size distribution in cell suspensions. Applications in lymphocyte studies are reported. (C.H.)

12467 THE USE OF THE $FeSO_4$ (FRICKE) DOSIMETER FOR MEASURING DOSES OF γ-RADIATION. Jozser Patko (Kossuth Lajos Tudomanyegyetem, Debrecen, Hungary). Acta Univ. Debrecen. Ludovico Kossuth Nom., 7: 61-9 (1961). (In Hungarian)

The applicability of the Fricke dosimeter was investigated in the high dose range of γ radiation. By determination of the generated ferric ions in the form of a thiocyanate

complex by the photometric method, the procedure described makes it possible to obtain the dose value by calculation without a calibration curve. Experiments were conducted with a solution consisting of 0.4 g $FeSO_4 \cdot 7\ H_2O$, 0.06 g NaCl, and 22 ml H_2SO_4 per l distilled water. A 2-ml volume of this solution was used to fill the dosimeters, the solution being put in glass tubes. After irradiation the contents of the tubes were added to 0.2 ml 15% KSCN solution and enough distilled water to make 5 ml, and the solution examined photometrically. The doses were calculated by the equation: $D = 1.09 \times 10^9 \times (M/\rho G)$; $M = (E_2 - E_1/\epsilon)$, where $E_2 > E_1$. E_2 is the extinction measured in the irradiated solution, E_1 is the extinction measured in the nonirradiated control solution, and ϵ is the molar extinction coefficient. Therefore, $D = (1.09 \times 10^9/\rho \times \epsilon \times G)(E_2 - E_1)$. In the experiments conducted the pH was 2.5, and for purposes of calculation the value of G was assumed to be 15.6. The dose can be calculated as follows $D = (1.27 \times 10^4/\rho)(E_2 - E_1)$. Because the density ($\rho$) of the dosimeter was 1.023 g/cm^3, $D = 1.24 \times 10^4 (E_2 - E_1)$ r. With this method the dose rate can also be determined as follows: $D(r/hr) = (10^9/\epsilon\ G \cdot t) \times (E_2 - E_1)$, t being irradiation time in hours. The absorbed dose expressed in rad is thus: $D(rad) = (10^9/\rho\epsilon\ G_{rad}) \cdot (E_2 - E_1)$; the G(rad) value is ~20 μM/l/1000 rad. The method described allows the use of stored as well as freshly prepared ferrous sulfate solutions. The small size of the dosimeter and its sensitivity in the higher dose ranges facilitates the determination of the strength of radiation sources as well as the measurement of doses in different parts of the irradiated human body. (BBB)

12468 QUASI-ADIABATIC CALORIMETER FOR THE DIRECT DETERMINATION OF RADIATION DOSE IN RAD. S. Genna, R. G. Jaeger, J. Nagl, and A. Sanielevici (International Atomic Energy Agency, Vienna). At. Energy Rev., 1: No. 4, 239-54(1963).

A quasi-adiabatic calorimeter with an automatic temperature-control system and accessories for electrical calibration and determination of external radiation beam dose is described. The basic theoretical background of the method is discussed. Calibration diagrams and their evaluation in the dose range above 20 rad/min with an accuracy of within ±1% are given. The instrument, which is constructed entirely from Tissue Equivalent Muscle (T.E.M.) material, can be easily moved for intercomparison and standardization purposes. (auth)

12469 APPLICATION OF THE FERROSULFATE DOSIMETRIC METHOD FOR METALLIC CONTAINERS. V. P. Trusova and Yu. S. Ryabukhin. At. Energ. (USSR), 15: 526(Dec. 1963). (In Russian)

The ferrosulfate dosimetry method is widely used with glass equipment; however, use of glassware is often impossible in radiation chemistry investigations involving the determination of the absorbed energy. An attempt was therefore made to adapt the method for use with stainless steel containers. The 0.8N H_2SO_4 used as dosimetric solution dissolves the steel and thus distorts the results; however, a pretreatment of the steel with hot, 96% HNO_3 passivates the surface so that even subsequent exposure to γ radiation does not activate it. The ferrosulfate solution may be kept for a whole month without attacking the container. (TTT)

12470 SILICON JUNCTION DETECTOR IN A MAGNETIC BETA-RAY SPECTROMETER. D. Berényi and T. Fényes (Inst. of Nuclear Research, Hungarian Academy of Sciences, Debrecen). At. Kozlemen., 5: Suppl. to No. 3-4, [Paper 8] 6p.(1963).

A silicon junction detector was placed in the focus of a toroid sector type beta spectrometer. In the magnetic beta spectrometer using Co^{60} and Cs^{137} sources the relative detection efficiency of the semiconductor detector, its pulse height–energy linearity, and the alteration of the full width at half-maximum of the total absorption peak as a function of energy were investigated, with emphasis on the region of the minimum detectable energy. (auth)

12471 STEREOGRAPHIC PROJECTOR FOR THE EVALUATION OF BUBBLE AND CLOUD CHAMBER PHOTOGRAPHS. Tibor Gemesey and Jeno Hering. At. Kozlemen., 11: 465-9(1963). (In Hungarian)

For the scanning and rapid evaluation of stereophotographs a mirror projector was built for the projection of films 60 × 60 mm or 24 × 36 mm in size. The projector device is removable and can be changed on the mirror support according to the film size. Adjusted with the use of a system of known reference standards, rapid measurements can be performed to establish approximate data in space. (auth)

12472 MEASUREMENT OF THE γ-SENSITIVITY OF A 4π β-COUNTER. A. Williams and P. J. Campion (National Physical Lab., Teddington, Middx., Eng.). Intern. J. Appl. Radiation Isotopes, 14: 533-40(Dec. 1963).

An experimental method of determining the γ sensitivity of a $4\pi\beta$-counter is described. The method is shown for eliminating the decay-scheme correction from the $4\pi\beta$-γ-coincidence method of measuring the disintegration rate of a radioactive source. (auth)

12473 A WEIGHTLESS CONDUCTIVE COATING FOR COUNTER WINDOWS AND SOURCE BACKING. L. B. Gardner and A. B. Kaufman. Intern. J. Appl. Radiation Isotopes, 14: 633-4(Dec. 1963).

It was found that Statnul, which is manufactured in Weston Instruments, may be substituted for Aquadag as a conductive coating for ion chambers. Although its resistivity is higher, it is sufficiently low to conduct essentially static charge. Its low density compared to Aquadag allows surfaces coated with it to have less self-absorption and to exhibit less scatter of the incident radiation. The best method of coating a surface with Statnul is to dip it into a beaker of the solution. Alternately, an excess amount of the solution may be brushed upon the material. Thin films should be kept under tension during the coating process. After allowing the solution to air dry, the material is lightly buffed until the gloss changes from dull to sheen. (P.C.H.)

12474 POLYACRYLAMIDE SOLUTIONS USED IN RADIATION DOSIMETRY—EFFECT OF ADDED ELECTROLYTE. M. R. Raju and E. W. Merrill (Massachusetts General Hospital, Boston and Massachusetts Inst. of Tech., Cambridge). J. Polymer Sci., Pt. B, 2: 13-17(Jan. 1964).

An investigation was carried out on a dosimeter based on the degradation of polyacrylamide by gamma radiation. The addition of NaCl to polyacrylamide solutions caused the viscosities of the samples to remain stable for very long periods of time. An hypothesis is given to explain the behavior of polyacrylamide as a polyelectrolyte. (P.C.H.)

12475 A NEW CHEMICAL METHOD OF X-RAY DOSIMETRY. Gyoergy Orban, Jozsef Patko, and Istvan Berta (Kossuth Lajos Tudományegyetem, Debrecen, Hungary). Magy. Radiol. 14: 162-8(June 1962). (In Hungarian)

An attempt was made to construct an inexpensive, simple, photochemical dosimeter to be used in connection with

x-ray therapy and other radiation medicine fields. It depends on the decomposition of carbon tetrachloride, in a mixture containing 90% of it and 10% alcohol. This mixture was stored in brown glass bottles to protect it from photodecomposition, and, when used, it was irradiated in clear glass vessels which were boiled in water for three hr previous to use. Under irradiation, hydrochloric acid is produced along with two parts of water. The pH of the solution was measured with a pH meter, but for roughly quantitative purposes for visual indication, bromcresol green indicator dye was added to the chemical mixture, the pH of which was adjusted to 5.4. The best dye concentration was found to be 0.09 mg/ml. Color changes varied with radiation doses and quantity of chemicals irradiated in the glass vessels. When the doses used were 0, 50, 100, 150, 200, 250, 300 r and the tubes contained 0.4 ml fluid, it was colored blue at 0, 50, and 100 r, pale blue at 150 r, green at 200 r, pale green at 250 r, and yellow at 300 r. When the fluid volume was 0.2 ml: blue, blue, green, yellow, yellow, yellow, yellow were the observed colors at the seven doses; and with 0.1 ml, blue, blue, yellow, yellow, yellow, yellow, yellow. The tests therefore showed that a volume of 0.4 ml indicated change optimally from 50 to 100 r, 0.2 ml from 100 to 150 r, and 0.1 ml 50 to 100 r. This method is most useful for dosimetry in the x-ray intensity range of 100 to 170 kv. (BBB)

12476 A WRIST BADGE FILM HOLDER FOR RADIATION MONITORING FILMS. A. J. Short (Liverpool Regional Radiation Monitoring Service). Radiography, 27: 225-6(July 1961).

The construction of a device for measuring radiation exposure of the hands is described and illustrated. A holder for a wrist-film is constructed from a Radiological Protective Service pattern film-badge holder, a wrist-watch strap, and two easily made metal clips. The film badge holder is first modified by removing the spring safety-pin clip from the top and then, with a hacksaw and a fine blade, sawing off the rounded lugs on the two halves of the plastic holder which normally fit within the spring clip. From a sheet of 0.04-in. mild steel, two clips are cut to the dimensions given ($\frac{1}{2} \times \frac{7}{8}$ in.). Slots are cut in the clips for the wrist straps. The tops of the clips are bent over to engage the lip around the edge of the holder. One clip may be a little larger than the other to allow clearance for the hinge of the film-badge holder. With a suitable wrist-watch strap the clips are threaded onto the narrow band of the strap with the wider hinge-end clip nearest to the buckle. This enables films to be changed without completely removing the holder from the clips. (BBB)

12477 SUMMARY OF NUCLEAR MEASUREMENTS AND DOSIMETRY OF GAMMA RAYS AND NEUTRONS FOR RADIATION EFFECTS STUDIES. Kent C. Humphreys (Edgerton, Germeshausen and Grier, Inc., [Goleta, Calif.]). p.635-40 of "Institute of Environmental Sciences, 1963 Annual Technical Meeting Proceedings." Mt. Prospect, Ill., Institute of Environmental Sciences, 1963.

Methods and apparatus are described for gamma and neutron dosimetry measurements. (R.E.U.)

12478 NEUTRON DECAY SPECTROMETER. Ratib A. Karam. Thesis, Gainesville, Fla., Univ. of Florida, 1963. 92p.

The neutron-decay spectrometer is based on spectral analysis of the protons resulting from neutron decay. It was calculated that 2.42×10^5 protons/min would be emitted from a beam of 10^{10} thermal neutrons/cm^3/sec, if all the decay protons were magnetically contained along a path length of 1 m. If the resolution, R, is defined by the relation $R = (E_p)_{max} - (E_p)_{min}/(E_p)_{max} - (E_p)_{min}$, where E_p is the energy of the proton, values for R of 55, 31 and 6.4% were calculated for neutrons of energies of 100 ev, 10 kev, and 1 Mev, respectively. The experimental set-up comprised a containment magnet of 1200 G, an analyzing magnet of 3500 G, and a 0.006" CsI(Tl) crystal mounted on an 18 in.-long light pipe, which was coupled to a photomultiplier. Experiments were conducted with a vacuum of 10^{-6} mm of Hg. A neutron beam, the thermal portion of which was measured to be 4.46×10^6 n/cm^2 sec was used. It was found that the expected 1/E distribution of neutrons is exhibited in two regions ($0.3 < E_p < 0.7$ kev; $2 < E_p < 20$ kev). The discontinuity and the displacement between the two regions is explained by different detection efficiencies for different energies. The neutron-decay spectrometer is a new and inexpensive instrument for neutron spectrometry in the kev energy region. It has the unique property of giving better resolution the higher the neutron energy. (M.P.G.)

12479 NEUTRON SPECTRUM MEASUREMENTS USING MULTIPLE THRESHOLD DETECTORS. William W. Gerken and Dick Duffey (Univ. of Maryland, College Park). 23p. (CONF-187-61)

From American Nuclear Society Meeting, New York, Nov. 1963.

The use of threshold detectors, which simultaneously undergo reactions with thermal neutrons and two or more fast neutron threshold reactions, was applied to measurements of the neutron spectrum in a reactor. A number of different materials were irradiated to determine the most practical ones for use as multiple threshold detectors. These results, as well as counting techniques and corrections, are presented. Some materials used include aluminum, alloys of Al–Ni, aluminum–nickel oxides, and magnesium orthophosphates. (auth)

12480 METHOD AND APPARATUS FOR DETECTING X-RAYS. (to Ontario Research Foundation). British Patent 945,621. Jan. 2, 1964. Priority date Dec. 14, 1960, United States.

An apparatus for detecting x rays in the soft energy range and, with suitable modification, in the soft to hard range is described. An evacuated chamber with an x-ray target positioned in the chamber that emits photoelectrons is used for soft x rays. The photoelectrons are accelerated from the target to an electron detector. For a wide range of x-ray energies, a plurality of targets placed one behind the other are provided. In order to measure the hardness of the x rays, the photoelectrons emitted from the series of targets are accelerated a different amount for each target and thus have different energies when reaching the electron detector. (M.C.G.)

12481 IMPROVEMENTS IN OR RELATING TO NUCLEAR PARTICLE DETECTION APPARATUS. John William Harold Wilkins (to United Kingdom Atomic Energy Authority). British Patent 947,533. Jan. 22, 1964. Filed Nov. 22, 1961.

A nuclear-particle detection apparatus is patented, in which the detector circuit can be placed at a considerable distance from the rest of the apparatus and is joined to it by a single connector. The remote detection unit consists of a scintillation counter, a photomultiplier tube, a transistor-oscillator EHT generator, and an emitter-follower circuit for feeding output pulses to a terminal. The supply connections to the generator and emitter-follower are made to the same terminal with separate low-pass filters, so that a single connector may be used for the supply and to trans-

mit signals. A circuit diagram for the remote detection unit and part of the local apparatus is presented. (M.P.G.)

12482 WELL-TYPE IONISATION CHAMBER. Jacques Engelmann (to Commissariat a l'Energie Atomique). British Patent 949,048. Feb. 12, 1964. Priority date June 8, 1959, France.

A well-type ionization chamber is described that provides an increased volume of uniform sensitivity, that is, the volume in which a radioactive source of constant intensity may be placed without the ionization current varying substantially. The separation distance of the electrodes varies along the chamber axis and has a minimum value in the central region. (R.E.U.)

12483 IMPROVEMENTS RELATING TO APPARATUS FOR MEASURING RADIATION PRODUCED IN NUCLEAR REACTORS. Alan James Salmon (to Associated Electrical Industries Ltd.). British Patent 949,826. Feb. 19, 1964. Filed June 11, 1959.

An apparatus was developed for measuring radiation that is especially applicable to measuring the power developed in a reactor. It consists of a fluid dielectric in which Cherenkov radiation is produced, shielding around the dielectric, and a light guide extending through the shielding and positioned to transmit light due to the radiation to an external point at which light-responsive apparatus is located. The light guide follows a curved zig zag or other irregular path to prevent transmission of harmful radiation such as gamma rays. The term "light guide" includes both rods of light-transmitting dielectric and arrangements of mirrors. (M.C.G.)

12484 DEVICE FOR HOLDING CONSTANT THE GAS DENSITY IN GAS-FLOW COUNTERS. Adolf Trost (to Rudolf Berthold). German Patent 1,154,205. Sept. 12, 1963. Filed July 14, 1962.

The gas-outlet of the counter is connected to the lower half of a vertically arranged tube that is partially filled with a fluid, e.g. mercury. The tube communicates with a large gas container the diameter of the tube being small compared with the diameter of the container. While the container is closed the tube is open to atmospheric pressure at the top. The device holds the gas density constant regardless of changes of air pressure or temperature. (Gmelin Inst)

12485 SCANNING DEVICE FOR MAPPING THE DISTRIBUTION OF RADIOACTIVE RADIATION. Rudolf Prag (to Siemens-Reiniger-Werke AG). German Patent 1,156,178. Oct. 24, 1963. Filed Dec. 17, 1959.

The device described is provided with means for contrasting enhancement. By scanning repeatedly with the device adjusted to different counting rates, a picture of the isoresponse curves is furnished that, until now, could only be gained by drawing isoresponse curves with the help of a scintigram. (Gmelin Inst)

12486 DEVICE FOR MONITORING RADIOACTIVE RADIATION. Volkhard Netz (to VEB Vakutronik). German Patent 1,156,513. Oct. 31, 1963. Filed Aug. 19, 1959.

The device described comprises a Geiger-Muller counter followed by a pulse shaping circuit, a rate meter, and a circuit that is arranged to discharge the condensor of the rate meter when a predetermined amount of radiation is received and which gives an audible or visible warning, the repetition frequency of the alarm signal being a measure for the radiation intensity. (Gmelin Inst)

12487 SPHERICAL PROPORTIONAL COUNTER. Karl-Heinz Weber, Johannes Kunze, and Karl Witowsky (to VEB Vakutronik). German Patent 1,156,514. Oct. 31, 1963. Filed June 7, 1961.

A sensitive, energy and direction independent, spherical proportional counter for the dosimetry of x and gamma rays is described. The spherical housing is made of lithium–beryllium–borate glass. The housing is filled with vapor or gas or a mixture of both, the effective atomic number of the gas ranging from 8 to 10. While the stopping power of the glass is smaller than the air equivalent, the stopping power of the filling is higher than the air equivalent. The inner surface of the housing is coated with a layer of aluminum, nickel, or copper. (Gmelin Inst)

12488 IONIZATION CHAMBER OPERATED WITH ALTERNATING CURRENT. Otto Balk. German Patent 1,158,186. Nov. 28, 1963. Filed Aug. 8, 1959.

The chamber medium is a mixture of solid dielectric bodies and gas, e.g. polythene plastic foam filled with gas. (Gmelin Inst)

12489 ARRANGEMENT FOR THE AUTOMATIC DISPLAY OF THE ATTENUATION CURVES OF X- OR RADIOACTIVE RAYS. Hans Taube (to VEB Vakutronik). German Patent 1,158,187. Nov. 28, 1963. Filed Mar. 24, 1959.

The arrangement described comprises two rotating disks on a common axis through which the radiation is transmitted, a radiation detector located behind the disks, and an oscillograph. One pair of the deflection plates of the oscillograph is connected with the exit of the detector and the other pair is fed with a deflection frequency that is synchronous with the rotation of the disks. The two disks rotate in opposite directions and have an azimuthally increasing thickness. (Gmelin Inst)

12490 ARRANGEMENT FOR THE MEASUREMENT OF THE DOSAGE OF IONIZING RADIATION. Ernst Alfred Frommhold (to VEB Vakutronik). German Patent 1,158,188. Nov. 28, 1963. Filed Oct. 14, 1960.

A dosimeter is described that comprises ionization chambers and an electrostatic voltage measuring instrument. The electrometer of a transportable measuring instrument is temporarily switched to a plurality of stationary ionization chambers each of which is partially enclosed in a separate unit including also the voltage source and the storage capacitor. A description of the units is given. (Gmelin Inst)

12491 VOLTAGE SOURCE FOR A RADIATION DETECTOR WITH A GEIGER-MUELLER COUNTER. Rolf Moehring and Rolf Neitsch (to VEB Vakutronik). German Patent 1,158,189. Nov. 28, 1963. Filed Dec. 27, 1960.

The voltage source described consists of a dynamo operated by hand and two series connections switched in parallel each of which consists of a rectifier and a storage capacitor. One of these storage capacitors supplies the high voltage for the counter tube and the other one is for delivering direct voltage to an audio-frequency amplifier. (Gmelin Inst)

12492 DEVICE FOR THE SIMULATION OF RADIOACTIVE RADIATION RELEASED BY AN ATOMIC EXPLOSION. Guenter Tralau (to Telefunken Patentverwertungs GmbH). German Patent 1,158,638. Dec. 5, 1963. Filed Mar. 30, 1961.

The device described consists of a high frequency transmitter with directivity and a high frequency receiver with a receiving antenna as well as a counter tube combined with a radioactive preparation and a dosimeter for measur-

ing the radiation of the preparation. The received intensity of the high frequency field influences the pulse rate received by the dosimeter. A detailed description of the wiring diagram is given. (Gmelin Inst)

12493 PORTABLE SCINTILLATION DETECTOR WITH A FLAT LARGE AREA PROBE FOR SURFACE MONITORING. Donald G. Ludlum (to Eberline Instrument Corp.). U. S. Patent 3,122,635. Feb. 25, 1964. Filed Dec. 3, 1958.

An alpha scintillation detector with a large-area flat probe is described. A counting system is included. The unit is resistant to damage from moisture, heat, cold, pressure, and shock. Complete specifications are given. (R.E.U.)

12494 METHOD AND APPARATUS FOR MEASURING THE DOSAGE OF X-RAYS AND GAMMA RAYS. Bernhard Gross (to Preston V. Murphy). U. S. Patent 3,122,640. Feb. 25, 1964. Filed May 13, 1960.

The electrical current produced by hard x rays and gamma rays is used to determine the dosage. A device is described in which the receiver of radiation comprises an outer scatterer of insulating material and an internal electrode adapted to receive Compton electrons produced in the scatterer. The voltage produced by the Compton effect in the insulator is electrically measured without the use of an external potential. (R.E.U.)

12495 RADIOACTIVE TREATMENT OF INSULATING MATERIALS AND PROCESS AND APPARATUS FOR MEASURING RADIOACTIVITY. John H. Coleman (to Radiation Research Corp.). U. S. Patent 3,123,511. Mar. 3, 1964. Filed July 21, [1962].

A method is described for producing dielectric materials that are resistant to ionizing radiation. The method consists of subjecting the material to massive doses of radiation that causes, first, an increased conductivity destroying the insulation properties, and then a reduction of conductivity to the preirradiation level or below. A related device for measuring radiation intensity or integrated dose is also described. (R.E.U.)

12496 FAST NEUTRON DOSIMETER FOR HIGH TEMPERATURE OPERATION BY MEASUREMENT OF THE AMOUNT OF CESIUM 137 FORMED FROM A THORIUM WIRE. D. A. McCune (to U. S. Atomic Energy Commission). U. S. Patent 3,125,678. Mar. 17, 1964.

A method and device for measurement of integrated fast neutron flux in the presence of a large thermal neutron field are described. The device comprises a thorium wire surrounded by a thermal neutron attenuator that is, in turn, enclosed by heat-resistant material. The method consists of irradiating the device in a neutron field whereby neutrons with energies in excess of 1.1 Mev cause fast fissions in the thorium, then removing the thorium wire, separating the cesium-137 fission product by chemical means from the thorium, and finally counting the radioactivity of the cesium to determine the number of fissions which have occurred so that the integrated fast flux may be obtained. (AEC)

ISOTOPE TECHNOLOGY

General

12497 (TID-7681) ISOTOPES TECHNOLOGY DEVELOPMENT PROGRAM. Fifth Annual Contractors Meeting, December 2 and 3, 1963. (Division of Isotopes Development, AEC). 72p.

A total of 35 discussions is presented on the applications and uses of isotopes. The subjects of the discussions include: activation analysis, spectrometry, crime detection, tracer applications in oceanography and geology, coal analysis, Mössbauer effect, safety, etc. (D.L.C.)

12498 THE RADIATION CHARACTERISTICS OF γ-SOURCES CONTAINING SAMARIUM-145 AND ENRICHED SELENIUM-75. S. V. Rumyantsev, V. A. Dobromyslov, A. S. Shtan, and E. E. Kulish. At. Energ. (USSR), 15: 511-14(Dec. 1963). (In Russian)

Radiation sources used for flow detection and process control should emit low-energy γ quanta while possessing a high specific activity. Sources containing Sm^{145} and Se^{75} which were recommended for such purpose, were evaluated by attempting to determine their suitability on the basis of the spectral composition of the emitted radiation. The Sm^{145} source was prepared by the irradiation of 0.01 g of Sm_2O_3 enriched in Sm^{144} by a total flux of 7×10^{19} n/cm^2. The activity of the source at the time of the experiment was 0.3 mg equivalents of Ra. Its spectrum exhibited, near the 39 and 62 kev lines, peaks at various γ energies, up to 1500 kev; this was probably due to the presence of various radioactive impurities, such as Fe^{55}, Fe^{59}, Cu^{64}, and possibly Eu^{152} and Eu^{154}. The dimensions of the required biological shield are dependent on the amount of these impurities. In order to be able to use Sm^{145} as a soft γ source, these impurities must be eliminated. The spectra of enriched and unenriched Se^{75} were examined by means of a scintillation γ spectrometer. The spectra were found to be identical, differing only in the intensity of the lines. The chief advantage of the use of the enriched Se^{75} sources lies in their high specific activity. (TTT)

12499 STUDIES ON Kr^{85} BREMSSTRAHLUNG SOURCES. H. Schaefer, G. Vormum, and W. Schmidt (Institut für Angewandte Isotopenforschung, Berlin-Buch). Kernenergie, 6: 704-10(Dec. 1963). (In German)

On the basis of methane absorption measurements, a variety of charcoal was chosen for krypton adsorption and the possibility of the use of Kr^{85}-loaded charcoal for the preparation of x-ray sources was investigated. The obtained spectra as well as the photon yield are reported, whereby gold-plated charcoal as adsorber found special consideration. (tr-auth)

12500 THE ISOTOPE INDEX. COMPLETE GUIDE TO THE ISOTOPES. Volume VII, July 1963. J. L. Sommerville, ed. Indianapolis, Scientific Equipment Co., 1963. 296p. $7.00.

A listing of stable and radioactive isotopes and labeled compounds is presented. The supplier, price, and specific activity are also given. (C.E.S.)

12501 RADIOACTIVE SOURCE CAPSULE WITH CAPSULE RETAINING AND RELEASING MEANS. Donald J. Tompos (to Industrial Nucleonics Corp.). U. S. Patent 3,122,643. Feb. 25, 1964. Filed June 2, 1958.

A capsule is described for the flexible mounting of a radioisotope within nuclear radiation gages without needless exposure of personnel. The capsule is of snap-in type with a circumferential groove. Once inserted in a source holder, the capsule is held securely by spring-loaded detent pins carried in the holder, which engage the groove of the capsule. A tong-like tool is used for insertion and removal of the capsule. (R.E.U.)

Industrial Applications

12502 (BM-RI-6373) USE OF TRITIUM TRACER TECHNIQUES IN STUDIES OF GASOLINE STORAGE STABILITY. Charles S. Allbright, Marvin L. Whisman, and Frank G. Schwartz (Bureau of Mines. Bartlesville Petroleum Research Center, Okla.). Dec. 1962. 20p.

Radioactive tracer techniques were used to gain a better knowledge of the types of compounds that cause gum formation in gasoline during storage. A selected organic compound was labeled with tritium and purified. An unstable gasoline was tagged by adding a small amount of the labeled compound. After storage of the gasoline at 110°F for 16 weeks, the gum that had formed was recovered. The amount of the test compound converted to gum was determined by liquid scintillation counting. About 70 compounds, including several classes and types, were studied. The compounds, listed in order of descending reactivity in the test fuel, were sulfur compounds, nitrogen compounds, polycyclic hydrocarbons, olefins, alkylbenzenes, and saturates. In the order of decreasing percentage of each in the gum, the compounds were monoolefins, alkylbenzenes, sulfur compounds, polycyclic hydrocarbons, nitrogen compounds, and diolefins. This type of information should be helpful in developing a method for predicting the storage stability of gasoline. (auth)

12503 A METHOD FOR SELECTING ISOTOPES FOR γ-RELAYS. M. L. Gol'din. At. Energ. (USSR), 15: 514-16(Dec. 1963). (In Russian)

Selection of a γ-emitting source for use in relays depends on several factors, such as the half life of the isotope, the optimum count rate of the detecting system and the γ equivalent of the material; in addition, the wall thickness of the completed source and the temperature of the medium to which the source is to be exposed, also play a role. This problem was specifically examined for the case of Co^{60} and Cs^{137}. Comparing the initial investment cost for a system designed to operate for 15 years, it was found that a 180-mg-equivalents-of-Ra source made of Cs^{137} is cheaper by a factor of about 6 than a corresponding Co^{60} source; the latter also requires additional shielding. On the other hand, the high melting point of Co makes it suitable for operations at elevated temperatures. For all other applications, the use of Cs^{137} is to be preferred. (TTT)

12504 PRESERVATION OF SOFT FRUIT BY RADIO-PASTEURISATION. Pierre Vidal (Conservatome, Lyon). Food Irradiation, 4: No. 1-2, A2-9(July-Dec. 1963).

Aspects of the problem of soft fruit preservation by radiation are discussed. Particular attention is given to fresh soft fruit treatment techniques, packaging, types of installations, and economic considerations. It is pointed out that the clearest and most consistent results were obtained with soft, thin-skinned fruit such as strawberries, blackberries and raspberries. (H.M.G.)

12505 PRESERVATION OF FOOD BY MEANS OF GAMMA RAYS. F. N. Matthee and P. G. Marais (Research

Inst., Stellenbosch, South Africa). Food Irradiation, 4: No. 1-2, A10-17(July-Dec. 1963).

Methods and problems of food radiopreservation by gamma rays are identified. A brief resumé of the results obtained abroad and a discussion of the first series of experiments conducted at Stellenbosch Institute are presented. (auth)

12506 RADIATION PRESERVATION OF GRAPES AND SOME OTHER GREEK FRUITS. G. Saravacos and B. Macris (Nuclear Research Center, Athens). Food Irradiation, 4: No. 1-2, A19-21(July-Dec. 1963).

The main results of a study on the pasteurization of two varieties of Greek table grapes are reported together with certain preliminary results of orange and dried fig irradiations, which are under way in the laboratory. (auth)

12507 LOW-DOSE GAMMA IRRADIATION OF FRESH FRUITS. P. B. Mathur (Atomic Energy Establishment, Bombay). Food Irradiation, 4: No. 1-2, A26-8(July-Dec. 1963).

As a result of irradiation with gamma-ray doses in the range 5-30 kilorad, no adverse effect on color, texture, taste, or flavor was found in any of the five fruits investigated. No ill effects on consumers, of any kind whatsoever, are likely to occur if fresh fruits are irradiated with such low doses. Thus, it appears that low-dose gamma irradiation of fresh fruits would be helpful in their transportation and marketing. (auth)

12508 SUMMARY OF FRUIT IRRADIATION AT WAGENINGEN. D. de Zeeuw (EURATOM, Holland). Food Irradiation, 4: No. 1-2, A29-30(July-Dec. 1963).

Use was made of 1 Mev electrons produced by a normal Van de Graaff accelerator in fresh soft fruit. In order to obtain an even dose distribution over the surface of fruit, it was packed one layer thick in small plastic boxes. Both upper and lower sides of these boxes were irradiated. In case of firmer fruit species, such as plums, these were also placed on mechanically driven rollers on which they were slowly rotated during irradiation. With this method the irradiation time was chosen twice as long as for the packed fruit so as to meet the total dose requirement. Dosimetry measurements were made by both chemical and physical methods. The dose rate was 2 Krad per second. Results obtained with 100 to 500 Krad doses are given for strawberries, raspberries, red and black currants, blackberries, cherries, and plums. (auth)

12509 RADIOPASTEURISATION OF TOMATOES. P. Vidal (Conservatome, Lyon). Food Irradiation, 4: No. 1-2, A31-4(July-Dec. 1963).

Loose and packaged tomatoes were irradiated with Co^{60} gamma rays. Doses ranged between 100 and 500 kilorads. The trials were conducted with several common varieties, the chief being Ribbed Perdigeon and Santa Marzano Roma. Results indicate that radiation effects on tomatoes depend on the dose, maturity of the fruit, subsequent storage temperature, and quality of the fruit. Maximum radiation doses were found to be a function of maturity, unripened tomatoes being more radioresistant. Ideal storage conditions for tomatoes just turning red are 6°C with a dose of about 300,000 rads, whereas at 6°C green tomatoes require a dose of 400,000 rads for maximum shelf life. Experiments revealed a critical point in the physiological development of the tomato before which irradiation retards the ripening process and after which the ripening process is enhanced by irradiation. Techniques for marketing irradiated tomatoes are reviewed, and economic advantages of the process are discussed. (H.M.G.)

12510 THE EFFECT OF GAMMA IRRADIATION ON THE PRESERVATION OF STRAWBERRIES. M. Herregods (l'Etude de la Conservation des Fruits et Légumes, Belgium) and M. De Proost. Food Irradiation, 4: No. 1-2, A35-8(July-Dec. 1963).

To investigate the possibility of increased storage life of strawberries, radiation effects on mycological infection, vitamin C content, color, and juice viscosity and density were studied in the Red Gauntlet variety. Red-ripe strawberries were exposed to a 3800 C Co^{60} source (flux 3×10^5 rad/hour). The fruit received doses of 0.1, 0.25, and 0.5 Mrad and was stored at 2–15°C. Mycological infections were greatly reduced at these doses, milder development being retarded by a factor of three as compared with the control. Determination of ascorbic acid content was based on N-bromosuccinimide oxidation. Vitamin C content decreased more rapidly in untreated than in irradiated strawberries. Color intensity was evaluated according to anthocyanin content, which increased with radiation dose but decreased with storage period. After irradiation, the strawberries were pressed and the juice filtered. The viscosity and the density of the juice from irradiated fruit was found to be reduced in comparison with untreated strawberries. (H.M.G.)

12511 GAMMA RADIATION SANITATION OF FISH AND BLOOD MEALS. A. van der Schaaf (Utrecht Universiteit) and D. A. A. Mossel. Intern. J. Appl. Radiation Isotopes, 14: 557-62(Dec. 1963).

Trade samples of fish and blood meal containing 10–14 per cent moisture were inoculated with $0.2-0.4 \times 10^6$/g of Salmonella binza and 0.2×10^6/g of spores of a strain of B. subtilis which had at least the same heat resistance as those of B. anthracis. This material was sealed in Polythene bags, filling them to the maximum, and irradiated in a Co^{60} γ-cell at 18°C with 0.50, 0.75 and 1.0 Mrad respectively. Bacteriological examinations made 72 hours after irradiation revealed that 0.50 Mrad secured final counts of S. binza below $^1/_{25}$ g (corresponding to six decimal reductions), while 1.0 Mrad reduced viable counts of the spores used to less than 10/g. The latter dose also reduced numbers of naturally present viable Lancefield group D streptococci by at least three factors of ten. No significant losses of available lysin occurred in any of the materials at any tested dose of γ-irradiation. Autoxidative changes in the lipid fraction of the materials were noticed in fish meal only, but even there solely at dosages ≥0.75 Mrad and limited to about a 100 per cent increase in peroxide value. Results indicate that the treatment of contaminated dry products of animal origin with γ radiation at a level up to 1 Mrad is a promising approach to the very much required terminal sanitation of many of such products. (auth)

12512 EXTENSION OF STORAGE LIFE OF GARLIC BULBS BY γ-IRRADIATION. P. B. Mathur (Atomic Energy Establishment, Trombay, India). Intern. J. Appl. Radiation Isotopes, 14: 625(Dec. 1963).

Garlic bulbs were packaged in polyethylene bags and irradiated with 5 krad of Co^{60} γ rays. Irradiated and control bulbs were stored at 11-12°C. Weight loss, number of bulbs sprouted, and number of bulbs decayed were greater in the control group than in the irradiated group. No adverse effect on the taste, flavor, texture, or pungency of irradiated garlic bulbs was determined organo-leptically at the end of seven months storage. (H.M.G.)

12513 RADIATION PROCESSING. Daniel I. Cooper, ed. Intern. Sci. Technol., No. 27, 22-34(Mar. 1964).

Irradiation processes in use today are reviewed. The chemical effects of irradiation are also discussed. (P.C.H.)

12514 THE POSSIBLE ROLE OF ULTRASOUND AND IONIZING RADIATION IN WINE AGING. Vernon L. Singleton (Univ. of California, Davis). Wines & Vines, 34: 31-4 (Aug. 1963).

Studies on maturation and aging of wine verified that chemical and sensory effects are produced in wine by ultrasound and by atomic radiation. These effects were studied by chemical and sensory analyses. Wine was treated with hydrogen, nitrogen, carbon dioxide, oxygen, and air with and without ultrasound. Samples of the five major types of wine (white and red dry, white and red sweet, and shermat) were so treated. The gases other than oxygen and air were relatively inert toward wine with or without ultrasound, except that hydrogen produced a very low redox potential. Ultrasound generally produced very small chemical changes including reduction in acidity, increase in pH, and decreased absorbance at 280 mμ (primarily due to phenolic compounds). Sensory changes, however, were definite. A panel of tasters judged that ultrasound slightly decreased hotness (except with O_2), increased oxidized flavors, decreased grape aroma, and slightly decreased bottle bouquet without increasing complexity (except with O_2). Over-all quality scores were usually decreased by ultrasound. Introduction of a special flavor by ultrasound was also noted. The same wines, bottled under nitrogen, were exposed to 80000 to 1000000-rad doses of γ rays in a Co^{60} cell. Irradiation decreased the color of both red and white wines, causing the whites to be judged as less aged in color and the reds more aged with respect to color. Volatile aldehydes were increased, redox potential decreased, and pH reflected a small decrease in total acidity in irradiated wines. The lower levels of irradiation apparently had several effects, which, except for reduced grape aroma, were judged generally favorable to quality, particularly in the white port sample. The higher levels of irradiation altered the wines so much that, judged as standard wine types, they were considered to be reduced in quality. A special flavor was also produced. It was concluded that dosages of the order of 100000 rad might be useful with some standard wines to increase complexity and decrease hotness. (TCO)

12515 PROCESS MONITORING EQUIPMENT USING NUCLEAR RADIATIONS. I. M. Taksar and V. A. Yanushkovski. p.386-9 of "Automatic and Remote Control. Vol. III." London, Butterworths, 1961.

Various monitoring systems now used in process control that employ radioisotopes are discussed. Design principles for radiometric relays are described. Examples of the use of such equipment are given. Design trends discussed include: relay systems in which speed and sensitivity can be varied widely while the reliability is constant, equipment to detect modulated radiation fluxes, and standardization of thickness and density gages. (M.C.G.)

12516 RADIOACTIVITY IN THE AUTOMATIC CONTROL OF MINING EXTRACTING AND CUTTING MACHINES. V. G. Segalin, E. S. Snagovski, and A. A. Rudanovsky. p.390-6 of "Automatic and Remote Control. Vol. III." London, Butterworths, 1961.

Automation of cutting combines and cleaning units for mine work using radioactivity is discussed. Methods of automatic steering of mining machines using the border between coal and rock for orientation were studied with a view to their automation. A sensor based on the Compton effect of the dispersion of γ rays in the free electrons of atoms in coal and rock was designed. Intensimetric equations of the sensor were determined. Rules governing intensity changes of radiation as a function of change of various parameters were experimentally established. The sensor was tested in mines producing coal of ~1.6 g/cm³ density. The rock was mainly clay and sand-clay shale varying in density from 2.05 to 2.66 g/cm³. The sensor was accurate to ±2 cm within a distance ±8 to 10 cm from the contact. (M.C.G.)

12517 AN OPERATING COMMERCIAL RADIATION CHEMICAL PROCESS— THE DOW ETHYL BROMIDE PROCESS. David E. Harmer and John S. Beale (Dow Chemical Co., Midland, Mich.). 17p. (CONF-110-3)

From American Institute of Chemical Engineers 56th Annual Meeting, 1963 Annual Meeting, Houston, Tex., Dec. 1963.

A new process for the manufacture of ethyl bromide in which hydrogen bromide is added directly to ethylene using gamma radiation as the reaction catalyst is described. Details of the design and usage of a novel laboratory prototype reaction vessel that was used to study the reaction in the mini-plant stage are given. It illustrates how data from the prototype were scaled up to the full-sized plant design. Operational experiences gained in the production unit over a period of nine months are included as illustrations of the scaling up of this radiation process from laboratory to prototype to production. (auth)

12518 ARTICULATED RADIOACTIVE SOURCE. John R. Bangs and Fred Maud (to Budd Co.). U. S. Patent 3,121,168. Feb. 11, 1964. Filed Aug. 14, 1959.

An articulate radioactive source is described that is capable of being transferred through a tortuous conduit by fluid pressure drive. The source is composed of several small sources with arcuate ends in a flexible conduit. (R.E.U.)

Power Application

12519 (HW-78658) ISOTOPIC SEPARATION AS A FACTOR IN THE SELECTION OF CANDIDATE HEAT-SOURCE RADIOISOTOPES. Charles A. Rohrmann (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 3, 1963. Contract AT(45-1)-1350. 16p.

A re-examination is made of the radioisotopes which were classified as requiring isotopic separation in HW-76323 and HW-78180, and four of the isotopes are identified as having advantages great enough to justify further consideration with or without isotopic purification. These promising isotopes are Cs^{134}, Ho^{166}, Tm^{170}, and Tl^{204}, and of these, Tl^{204} is believed to be the most promising, if an effective separation process for this isotope can be achieved. (D.L.C.)

12520 (MLM-1182) RADIOISOTOPES FOR HEAT SOURCES. I. CALCULATIONS FOR PREPARATION OF U^{232} BY IRRADIATION OF Th^{230} AND Th^{232}. K. W. Foster (Mound Lab., Miamisburg, Ohio). July 1, 1963. Contract AT(33-1)-Gen-53. 12p.

Calculations were made to determine the quantity of uranium-232 that could be obtained from a 30,000 kilogram mixture of 15% thorium-230 and 85% thorium-232. The calculations indicated that the starting material could be recycled 14 times in a reactor with an assumed flux of 3×10^{14} neutrons cm^{-2} sec^{-1} to yield 3.3 kilograms of uranium-232. Since a large quantity of starting material is available, and since the economics of reactor irradiation are not prohibitive, uranium-232 might be a good candidate as an isotopic power source. (auth)

Separation and Production

12521 (BNL-823(p.57-65)) HOT LABORATORY DIVISION. L. G. Stang, Jr. (Brookhaven National Lab., Upton, N. Y.).

Efforts to prepare ultrahigh specific activity Mg^{28} by recoil techniques established that recoil does occur, the range of the most energetic Mg^{28} atom being 0.2 to 1.2 mg/cm^2, effecting an enrichment of about 100 to 200. The excitation functions for the $Mg^{26}(t,p)Mg^{28}$ and $Mg^{25}(t,\alpha)Na^{24}$ reactions were measured. The $Ar^{40}(\alpha,2p)Ar^{42}$ reaction was observed, and evidence for the $Ar^{40}(t,p)Ar^{42}$ reaction is being sought. The thick target yield of the $Cr^{50}(\alpha,2n)Fe^{52}$ reaction was measured as 8.17 $\mu C/\mu ah$ as efforts to prepare this product were continued. The cause of occasional low yields from Sr^{87m} generators is being investigated. Comparison of reactions induced by tritons in targets of medium Z in accelerators on the one hand and in reactors on the other is in progress. A study of the possibility of electronically simplifying gamma spectra prior to pulse-height analysis is being continued. As^{72} can be milked in 44% yields from diaminonaphthalene-Se^{72}, but, thus far, only accompanied by 10% Se^{72} contamination. An extended table of nuclidic masses was constructed in a way such that the standard deviation between calculated and measured masses was only 0.35 Mev for 763 cases. A study of the behavior of Te and Mo on alumina indicated that the valence state of Te may be a factor which will have to be controlled more closely in connection with the preparation of I^{132} and Tc^{99m} generators. In a study of the effect of chelation on the atomic spin–orbital coupling in a heavy atom such as an actinide element, singlet-triplet transitions in anthracene could not be induced by mixing singlet and triplet states of the aromatic with the charge transfer states of the complex between anthracene and ferric acetylacetonate. A free radical of the complex between Se and 1,2-diaminobenzene was prepared. Polarographic and chronopotentiometric investigations indicated that two different U(V) species are formed, as a result of electroreduction of U(VI) and electrooxidation of U(IV), respectively. Double layer and adsorption effects were encountered in a polarographic study of the bismuth-EDTA complex. Computer analysis of current reversal chronopotentiometry together with an improved laboratory technique increased by a factor of 10 the range of application in determining second-order rate constants. Pyrocatechol violet was found to be a suitable indicator for volumetric determination of Th. The problem of "low" yields of I^{132} was solved when the difficulty was traced to slow precipitation of Te^{132} from a basic solution on standing. Conditions were determined by which I^{131}/I^{132} ratio in radioiodine milked from I^{132} generators can be reduced to as low as 0.014%. Adsorption of Tc^{99m} onto small particles of inert material is being studied as a possibly superior replacement for colloidal gold and I^{131}-labeled Rose Bengal for certain medical applications. The I^{132} production schedule was changed in a way that obviates difficulties caused by delays in restarting the reactor. A neutron generator was acquired and preliminary steps to install it have begun. Plastic glove boxes were reinforced as a result of tests carried out to determine effects of increased internal pressure. "D" waste inventory reached a low of 23,000 gal. (auth)

12522 (PAN-458/XVI) NE KORRODIRUYUSHCHAYA NASADKA ISOTOPNOI OBMENNOI KOLONNY DLYA OBOGASHCHENIYA N-15. (Noncorrosive Packing on an Isotopic Exchange Column for Enrichment of N-15). Anatol Selecki (Seletski) and Jan (Yan) Grachyk (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). Mar. 1963. 11p.

The properties of foam glass granules (0.5–4 mm diameter) as a corrosion resistant packing of an isotope exchange column for enrichment of N^{15} were investigated. The geometrical surface of the packing, the flooding capacity of the column, the lost head, and the trapping and height of a theoretically equivalent disk were determined. (tr-auth)

12523 (SGAE-1963/3B) SIMPLE AND RAPID PRODUCTION OF CARRIER-FREE SODIUM-24. H. Riedl, W. Parker, H. Bildstein, and N. Getoff (Osterreichische Studiengesellschaft für Atomenergie G.M.B.H., Seibersdorf, Austria). Sept. 1963. 12p.

A simple and rapid method is described for the production of carrier-free sodium-24 following the irradiation of magnesium with fast neutrons according to the nuclear equation: $Mg^{24}(n,p)Na^{24}$. Based on the irradiation of MgO or $Mg(OH)_2$ in the presence of water followed by extraction of Na^{24} also with water and with a final purification stage, involving ion exchange, the described method should prove very suitable for work at the curie level. Detailed data are given for the pre-purification of the commercial magnesium target material and for its preparation as a slurry so as to take advantage of recoil products produced during the irradiation. Curves and data are presented showing the yield dependence on the water content of the magnesium target and of the efficiency of water as an extraction medium. In conclusion, the final purity of Na^{24} separated using the described method is discussed. (auth)

12524 THE SEPARATION OF HYDROGEN ISOTOPES ON TYPE A, SYNTHETIC ZEOLITES IN THE COBALT, ION-EXCHANGE FORM. Z. V. Gryaznova, G. M. Panchenkov, V. S. Parbuzin, T. G. Andronikashvili, G. V. Tsitsishvili, O. T. Nikitin, and K. E. Avaliani (Moscow State Univ. and Chemistry Inst., Academy of Sciences, Georgian SSR). Dokl. Akad. Nauk SSSR, 153: 1105-7 (Dec. 11, 1963). (In Russian)

Samples of molecular sieves containing 3.69 to 14.20 wt % of cobalt were made by treating the sodium form of a typical zeolite with a 0.05N cobalt chloride solution a number of times. A total of 67.7% of the sodium ions were replaced in the sample containing 14.2 wt % cobalt. The lattice parameters were 12.32 Å for the initial NaA, 12.29 Å for the Co_1A, Co_3A, and Co_4A samples, and 12.28 Å for the $Co_{12}A$ sample. The molecular sieve was contacted with a gaseous mixture of H_2 and HD, or with a mixture of H_2, HD, and D_2 at a liquid nitrogen temperature. The single-state separation coefficient was calculated by determining the ratio of HD/H_2 on the zeolite and in the gas phase on a mass spectrometer. The content of HD in the initial mixture was varied from 0.94 to 9.14 mole %, and the initial content of D_2 was varied from 0.26 to 2.14 mole % D_2. The single-stage separation coefficient did not depend on the initial isotopic composition. The absorption capacity of the zeolite increased with increasing cobalt content, but the separation coefficient decreased with increasing cobalt content, and was a maximum for the sodium form of the zeolite. The isotopic exchange was complete in 4 to 15 minutes. (TTT)

12525 SEPARATION OF BORON ISOTOPES. VI. ETHYL ETHER, ETHYL SULFIDE, AND TRIETHYLAMINE-BF_3 SYSTEMS. A. A. Palko and J. S. Drury (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 40: 278-81 (Jan. 15, 1964).

The BF_3 complexes of ethyl ether, ethyl sulfide, and triethylamine were studied. Isotopic equilibrium constants

for the reactions $B^{10}F_3(g) + B^{11}F_3 \cdot donor(l) \rightleftharpoons B^{10}F_3(g) + B^{10}F_3 \cdot donor$ were measured at several temperatures for each of the three systems. Vapor pressures of the ethyl sulfide complex, and rates of exchange of boron between BF_3 and $BF_3 \cdot Et_3N$ were also determined. (auth)

12526 PROBLEMS IN ELECTROLYTICAL SECONDARY STANDARDIZATION OF Co^{60} PLANE SOURCES I. J. Flachowsky (Institut für Angewandte Radioaktivität, Leipzig). Kernenergie, 6: 694-700(Dec. 1963). (In German)

An investigation was made, on a special example—the electrolytic separation of Co^{60}—to determine under what conditions it is possible to use the amount of current flowing during electrolysis to ascertain the activity. The apparatus is described and the dependence of the current output on the electrolytic conditions is explained. (tr-auth)

12527 AN ELECTROLYTIC COUNTERCURRENT COLUMN FOR ISOTOPE SEPARATION: A SIMPLIFIED THEORETICAL APPROXIMATION. Anatol Selecki (Technical Univ. of Warsaw and Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nature, 201: 61-2 (Jan. 4, 1964).

The possibility is considered of multiplying a single, electrolytic isotopic separation effect in a continuous process occurring in an electrolyzer with a countercurrent flow and conversion of two immiscible liquid phases. Such a process may, among other applications, be used for the enrichment of lithium. The theoretical possibilities of enrichment by this method and the direction of interactions of the principal parameters of the process were determined. (M.C.G.)

12528 FUNDAMENTAL STUDIES ON THE ION EXCHANGE SEPARATION OF ISOTOPES. VIII. SEPARATION FACTOR OF URANIUM ISOTOPES. PART 2. Hidetake Kakihana, Kōzō Gonda, Hitoshi Sato, and Yoshihiro Mori (Tokyo Refinery. Atomic Fuel Corp. and Tokyo Inst. of Tech.). Nippon Genshiryoku Gakkaishi, 5: 990-3(Dec. 1963). (In Japanese)

Breakthrough experiments on U(IV) and U(VI) were done using an anion exchange resin column of 100 cm height and 1.2 cm diameter with 8N hydrochloric acid. Uranous ions gave better separation factor (0.9993) than uranyl ions (1.0000). Mixed solutions of uranous and uranyl ions gave good separation factors (0.9992 ~ 0.9986), which can be explained by effective contribution of the isotope effect of the electron-exchange reaction: $U^{235}(VI) + U^{238}(IV) \rightleftharpoons U^{238}(VI) + U^{235}(IV)$. The results agree with the theoretical values derived from the following fundamental equation by assuming ke = 1.002. $\ln S_{238}^{235}(U) = \ln S_2 + \ln\{1 + (S_1 ke S_2^{-1} - 1/-1 + \bar{\rho})\} + \ln\{1 + ((ke^{-1} - 1)/1 + \rho)\}$, where S_1 is the separation factor with the system containing only uranous ions, S_2 is for uranyl; ρ and $\bar{\rho}$ are the ratios of uranyl ions to uranous ions in the solution and in the exchanger resin, respectively. (auth)

12529 METHOD AND DEVICE FOR THE SEPARATION OF GAS MIXTURES BY THE ACTION OF CENTRIFUGAL FORCES. Hans-Georg Noeller. German Patent 1,154,793. Sept. 26, 1963. Filed Jan. 4, 1956.

The method described comprises the steps of injecting the gas tangentially into a vessel with a circular cross section, of choosing the jet velocity, the gas pressure within the vessel, and its length in such a way that a circular flow is established, and of extracting the mixture enriched in heavy molecules from the circumference and the mixture depleted from the center of the vessel. The vessel is rotated by the action of the injected gas. (Gmelin Inst)

12530 METHOD FOR THE CONTINUOUS ENRICHMENT OF HEAVY WATER IN HOT-COLD COLUMNS. Bengt J. Eriksson (to Allmanna Svenska Elektriska Aktiebolaget). German Patent 1,155,096. Oct. 3, 1963. Priority date Apr. 16, 1958, Sweden.

The method described for the continuous enrichment of heavy water by isotopic exchange between water and a circulating gas in hot-cold columns comprises the cooling of the gas by mixing with water in counter current in a heat exchanger before it enters the cold column. Prior to passing into the heat exchanger the water is saturated with the gas used for the isotopic exchange. A detailed description of the flow diagram is given. (Gmelin Inst)

12531 METHOD FOR THE ENRICHMENT OF AMMONIA IN DEUTERIUM BY ELECTROLYSIS. Fernande Botter, Grégoire Dirlan, Henri Sack, and Bernard Lefrancois (to Commissariat à l'Energie Atomique and Houilleres du Bassin du Nord). German Patent 1,155,425. Oct. 10, 1963. Filed Aug. 29, 1960.

Electrical conducting liquid ammonia is electrolyzed at a pressure between barometric pressure and 1000 at. The ammonia becomes electrically conducting by the addition of a basic electrolyte, e.g., ammonium bromide. (Gmelin Inst)

MATHEMATICS AND COMPUTERS

12532 (AD-407819) ON SOME PROBLEMS IN THE THEORY OF PARTICLE COUNTING AND THE INFINITELY MANY SERVER QUEUE. Joseph L. Gastwirth (Columbia Univ., New York). Mar. 1963. Contract Nonr-266(59). 75p.

The renewal theoretic approach to particle counting is summarized, together with a shorter proof of Pyke's formula for the time distribution between successive registrations. Takacs' methods were used to solve the problem in which the dead-time is allowed to have Erlang-r distribution (r > 1), rather than the exponential distribution. The distributions used are max-m distributions, the maximum of m exponential distributions each with parameter μ. After determining the number of impulses present in the type II counter (the queue size problem), the problem of particle counting is considered. (auth)

12533 (JINR-P-1497) ALGORITM VYCHESLENIYA ELEMENTARNYKH SIMMETRICHESKIKH MNOGOCHLENOV. (Algorithm for Calculating Elementary Symmetrical Polynomials). I. N. Kukhtina and D. P. Shishkov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R.) 1964. 9p.

An effective method for calculating the elementary symmetrical polynomials that are applied to some problems of quantum mechanics and higher algebra is treated. This method is realized at the electronic computer by using a brief program. (auth)

12534 FUNCTIONAL DIFFERENTIAL CALCULUS OF OPERATORS. F. Rohrlich (Univ. of Iowa, Iowa City). J. Math. Phys. (N. Y.), 5: 324-31(Mar. 1964).

The functional derivative with respect to operators of operator functionals is defined for operators that satisfy certain commutation relations of interest in quantum field theory. From this definition, a functional differential calculus is developed for functionals of tensor as well as spinor fields. It is noted that an implicit definition of the functional derivative can always be given while an explicit one seems to exist only for those operator fields that need not be restricted by supplementary operator conditions, and for which not more than one derivative occurs in the commutation relations. (auth)

12535 POWER AND EXPONENTIAL MAPS OF LIE GROUPS. Charles Walker Lemmon. Thesis, Charlottesville, Va., Univ. of Virginia, 1963. 42p.

Let G be a compact connected Lie group. One may consider the set L of elements of order 2 in G; thus $L = \{g: g \in G, g^2 = e\}$ where e is the identity element of G. The set L may be thought of as the fixed point set of the involution λ: $G \to G$ defined by $\lambda(g) = g^{-1}$. It is proved that a necessary condition for the sum of the Z_2 Betti numbers of L to equal the corresponding sum for G is that the induced map λ_* be the identity homomorphism on homology. This is proved with the aid of the Smith sequence for an involution. The first sum is never larger than the second. We show that equality need not always hold; a counterexample to equality is the group Spin (10). The set of square roots S of an arbitrary element y of G is considered, and it is proved that the sum of the Z_2 Betti numbers of S is always less than or equal the corresponding sum for the centralizer C_y of y. The maps p_k: $G \to G$ for each integer $k \geq 2$ are defined by $p_k(g) = g^k$. If y is a fixed element of G, $p_k^{-1}(y)$ is the set K of kth roots of y. It is proved that K is the union of a finite number of disjoint compact even-dimensional submanifolds of the underlying manifold of G. Moreover, it is proved that the differential of p_k at any point x in $p_k^{-1}(y)$ is a monomorphism on any complementary space to the tangent space to the component submanifold which contains x, when this latter space is thcught of as a subspace of the tangent space to the manifold of G at x. In particular, it is one-to-one on the orthogonal complement or normal vector space to the submanifold at x when an inner product is assumed. It is then proved that the exponential map exp: $g \to G$, where g represents the Lie algebra of G, has similar properties. In particular it is proved that if p is a point of G, $\exp^{-1}(p)$ is a countable union of compact disjoint submanifolds of g and that at each point x in $\exp^{-1}(p)$ the differential is a monomorphism on the normal space to the tangent space of the component submanifold of x at the point x. Lastly, the unitary group U(n) and the set L for this group are considered. The set L is proved to be a finite union of complex Grassmann manifolds. (Dissertation Abstr.)

METALS, CERAMICS, AND OTHER MATERIALS

General

Refer also to abstracts 12045 and 12857.

12536 (AD-412904) STUDIES OF REFRACTORY ALLOY SHEET MATERIALS. Quarterly Report, March 15, 1963 to June 15, 1963. Robert Q. Barr, Paul R. Pfefferle, and M. Semchyshen (Climax Molybdenum Co. of Michigan, Detroit). Contract NOw-62-0419-c. 9p.

The following alloys were consolidated by the vacuum-arc-casting process: Mo + 1.59% Nb + 0.52% Ti + 0.21% Zr + 0.068% C, Mo + 1.30% Ti + 0.35% Zr + 0.093% C, and W + 3.10% Mo + 0.04% Zr + 0.001% C. Machined blanks from the ingots were extruded to rectangular bar form in preparation for rolling to sheet. The extruded bars were evaluated in terms of recrystallization behavior and response to solution and aging treatments. (auth)

12537 (AD-426732) DEFENSE METALS INFORMATION CENTER SELECTED ACCESSIONS. Mary F. Banks, comp. (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Dec. 1963. 65p.

Abstracts are presented of 95 selected documents and journal articles on subjects within the technical scope of DMIC. The abstracts are arranged according to high-strength alloys, light metals, nonmetallics, refractory metals, and miscellaneous. Author, subject, and DMIC numerical indexes are included. (D.L.C.)

12538 (ARF-B201-27) DEVELOPMENT OF A Ti–Al–Cb ALLOY FOR USE AT 1200–1800°F. Joseph B. McAndrew and Charles R. Simcoe (Illinois Inst. of Tech., Chicago. Armour Research Foundation). June 1963. Contract AF33(616)-7262. 34p. (ASD-TR-61-446(Pt.II); AD-408732).

A study was made on the Ti–Al–Nb system for high temperature alloys with useful strengths above 1200°F. Composition variations included: niobium from 17.5 to 35%, aluminum from 12.5 to 17.5%, and the addition of smaller amounts of zirconium, hafnium, tin, carbon, or boron. Short-time tensile properties were determined for one strain rate (0.0029 in./in./min.) at 1600°F. Stress-rupture properties were obtained for a variety of temperatures and stresses. The Larson-Miller parameter was used to present these stress-rupture data so that the rupture life at various temperatures could be presented on a single plot for each alloy. (auth)

12539 (BM-RI-6341) A SYSTEM FOR ELECTRON-BEAM MELTING. F. W. Wood, J. L. Hoffman, W. E. Anable, and R. A. Beall (Bureau of Mines. Albany Metallurgy Research Center, Ore.). Apr. 1963. Contract AT(11-1)-599. 37p.

For melting and purifying reactive and refractory metals, two electron-beam furnaces have been constructed and operated on the principle of high-powered vacuum diodes. It was necessary to design the vacuum and electrical systems, mechanical features, and operating procedures to cope with dynamic conditions. Vacuums of 10^{-5} torr, tens of kilowatts of power at 5 to 10 kilovolts, and the evolution of impurities at thousands of liters per minute constitute a challenging combination. The furnaces have been used to melt either button specimens weighing several hundred grams or, by feeding material as a consumable electrode, small ingots weighing several kilograms. Hafnium is among the metals that can be purified. For example, hafnium starting material with RHN 94B was softened to RHN 70B after 2 hours of melting under a 25-kw electron beam, and impurity levels were reduced as follows: Oxygen, from 700 to 350 ppm; nitrogen, from 71 to 20 ppm; hydrogen, from 6 to 1 ppm; aluminum, from 75 to <20 ppm; chromium, from 80 to <10 ppm; iron, from 100 to 40 ppm; and silicon, from 40 to <20 ppm. (auth)

12540 (EURAEC-493) IN-PILE CORROSION OF NUCLEAR MATERIALS. Quarterly Report No. 2, July 1–September 30, 1962. (Centre d'Etude de l'Energie Nucleaire, Mol, Belgium). Work Performed under United States–Euratom Joint Research and Development Program. Contract 084-62-3 RDB. 13p.

Electrochemical measurements by the coulostatic galvanostatic single shot method on zirconium submitted to different surface treatments were continued. Etching was not suitable due to formation of a surface film. The results from oxidation experiments were in agreement with the weight gains produced below 260°C. Construction and testing of the new in-pile loop for electrochemical measurements was continued. Construction of the out-of-pile alarm and control systems was started. More experiments on the passivation of aluminum were performed out-of-pile. (auth)

12541 (GEAP-4089(Vols.I and II)) PROCEEDINGS OF THE USAEC SYMPOSIUM ON ZIRCONIUM ALLOY DEVELOPMENT, [HELD IN] CASTLEWOOD, PLEASANTON, CALIFORNIA, NOVEMBER 12-14, 1962. H. H. Klepfer, comp. (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Nov. 30, 1962. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. (EURAEC-594). 828p.

Twenty-two papers presented at the USAEC Symposium on Zirconium Alloy Development are given. Separate abstracts were prepared for 17 papers. Five papers were previously abstracted for NSA. (M.C.G.)

For abstracts of individual papers see: 12576, 12577, 12578, 12579, 12580, 12632, 12633, 12634, 12635, 12636, 12637, 12638, 12639, 12640, 12641, 12642, and 12723.

12542 (GEAP-4484) SPECIFIC ZIRCONIUM ALLOY DESIGN PROGRAM. Quarterly Progress Report No. 7. H. H. Klepfer, J. L. Jaech, R. E. Blood, H. E. Perrine, and M. E. Urata (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Jan. 1964. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 53p. (EURAEC-943)

Completion of experimental work on the first round of 31 alloys and on the second round of 10 alloys is reported. Steam exposures of at least 3000 hours were finished for all alloys at all test temperatures, with exposures of some coupons to 6700 hours. Mathematical expressions were derived to describe all first round data for corrosion rates and hydriding rates at 300, 400, and 500°C as a function of Nb, Cr, Fe, and Cu content. Solution of the equations for particular service temperatures yields Zr–Cr alloys as optimum at lower temperatures and Zr–Cu–Fe alloys as optimum at the higher temperatures. The second round test results show that neither Ni nor Be additions to Zr–Cr or Zr–Cu improve the performance over that of the optimum Zr–Cr or Zr–Cu–Fe alloys. Post-corrosion ductility was investigated for the first round alloys. Alloys

with a high original ductility are embrittled less by a given amount of hydrogen than are alloys with low original ductility. From the second round tests, it was found that raising the final alpha annealing temperature from 565 to 788°C gives better over-all corrosion, hydriding performance, and resistance to hydrogen embrittlement for both the Zr–Cr and Zr–Cu alloys tested. Methods for the determination of hydrogen in Zr alloys are discussed. A collection is presented of wet chemical methods for determining alloy composition for N_2, Cr, Fe, Ni, Cu, Sn, and Nb. (R.E.U.)

12543 (GEMP-31A) HIGH-TEMPERATURE MATERIALS PROGRAM. Progress Report No. 31, Part A. (General Electric Co. Advanced Technology Services, Cincinnati). Jan. 24, 1964. Contract AT(40-1)-2847. 35p.

Stress-rupture and creep characteristics of rhenium were measured at 2600°C in hydrogen and argon. Additional testing of molybdenum at 2200°C in hydrogen and argon was also conducted. The majority of these tests were conducted over periods of 1 to 20 hours and, in general, confirmed prior test results. Fabrication studies of W–25Re were continued and resulted in the production of six sheets of W–25Re (0.06 cm thick by 7.6 cm wide by random lengths). All sheets were free of sigma phase and agglomerates of fine tungsten powders. The fabrication of the second elevated temperature cartridge for the irradiation of tungsten creep-rupture specimens is nearing completion. Creep-rupture testing of molybdenum specimens in the temperature region of 870° to 1100°C was initiated. The irradiation of these specimens to a fast neutron dosage of about 7×10^{18} nvt ($E_n \geq 1$ Mev) did not reveal any significant changes in the creep properties. Additional heat treatment of the vendor recrystallized material of control specimens showed a consistent lowering of rupture life and a corresponding increase in the creep rate. Isochronal annealing of irradiated molybdenum resistivity specimens showed recovery peaks at 0.15 and 0.31 T_m, consistent with data reported by others for BCC metals. During the course of isochronal annealing of unirradiated warm-worked molybdenum, a peak was observed at about 0.36 T_m, which is below the normal recrystallization temperature but in the region of the stress relieving temperature. It was also noted that the radioinduced increase in resistivity is greater for recrystallized material (120%) than for specimens which were in a warm-worked condition (80%). Hot-hardness measurements were initiated on unirradiated tungsten single crystals. The hardness decreased rapidly from room temperature up to about 300°C and subsequently changed slowly from 300 up to 1000°C. Single crystals of tungsten were irradiated. Testing of A-286 alloy specimens containing various amounts of natural boron was continued. Preliminary microstructure observations of these alloys indicated that significant grain growth occurred in the stressed region of the unirradiated test specimen for the alloy containing the least amount of boron. (auth)

12544 (HW-74204) SPECIFICATION FOR HIGH-DENSITY URANIUM DIOXIDE (NUCLEAR GRADE). H. J. Anderson and R. J. Anicetti (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 11, 1962. Contract [AT(45-1)-1350]. 3p.

Specifications are presented for UO_2 which is to be used in packed particle fuel elements manufactured by vibrational compaction, swaging, or similar processes. The specifications include sampling and control procedures, chemical properties, physical properties, test reports, packing and marking, and inspection. (D.L.C.)

12545 (HW-74204(Rev.1)) SPECIFICATION FOR HIGH-DENSITY URANIUM DIOXIDE (NUCLEAR GRADE). H. J. Anderson and R. J. Anicetti (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 9, 1963. Contract [AT(45-1)-1350]. 5p.

Specifications are presented of the physical and chemical requirements for high-density UO_2 for use in packed particle reactor fuel elements manufactured by vibrational compaction or a similar process. Sampling and control procedures, test reports, packing and marking, and inspection are discussed. (D.L.C.)

12546 (HW-76303) CERAMICS RESEARCH AND DEVELOPMENT OPERATION QUARTERLY REPORT, JULY–SEPTEMBER 1963. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Contract AT(45-1)-1350. 139p.

Separate abstracts were prepared for the three major topics ceramics research, fuels development, and fuels testing and analysis. Within these major sections are a total of 59 papers. (R.E.U.)

For abstract of individual section see: 12643.

12547 (HW-76303(p.3.1-37)) FUELS DEVELOPMENT. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Various phases of ceramic fuels development are considered. Plutonium distribution in impacted UO_2–PuO_2 was studied. The fabrication of PRTR fuel elements is reported. The construction of a vibrational compaction facility in the Plutonium Fabrication Pilot Plant and its use for EBWR fuel elements are reported. PRTR fuel element cladding corrosion for UO_2, PuO_2, and UO_2–PuO_2 containing halogen and water impurities was studied. A cell for testing of fuel-cladding compatibility under simulated PRTR temperatures and pressures was designed and constructed. A can-die-punch assembly for impacting cermet sheets is reported. The effects of UO_2 content in UO_2–W on strength were studied. The preparation of PuO_2–SS cermets and the melting of metal matrices in them are reported. The fabrication of fuel rods for EL-4 is discussed. The repair of an irradiation-damaged PRTR fuel element and rejuvenation of an MTR element are reported. The distribution of Sm_2O_3 in impacted UO_2–2 wt % Sm_2O_3 and UO_2–10 wt % Sm_2O_3 was studied. The magnetic force welding of Incoloy-800 components and of tantalum components is reported. The inspection and procurement of Zircaloy tubes for EBWR UO_2–PuO_2 fuel elements are discussed. (R.E.U.)

12548 (HW-76566(Rev. 1)) SPECIFICATION FOR NUCLEAR-GRADE PuO_2, SINTERABLE POWDER. H. J. Anderson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 9, 1963. Contract AT(45-1)-1350. 6p.

Specifications are presented for the chemical and physical requirements of PuO_2 which is to be used in the fabrication of EBWR and PRTR fuel elements. Sampling, testing, performance test, test reports, and packing and marking are discussed. (D.L.C.)

12549 (HW-78788) COEXTRUDED CARBON STEEL TO ZIRCALOY-2 PROCESS TUBE JOINT. Design Test 1126 Final Report. Walter E. B. Lander (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 6, 1963. Contract AT(45-1)-1350. 30p.

Strain gage measurements were made to study the forces at the interface between the carbon steel and the Zircaloy-

2 in a coextruded process tube. Strain curves were taken during the heat cycles, and the results are interpreted in terms of changes in total strain. Moduli of elasticity were calculated for different sections of the joint. (D.L.C.)

12550 (HW-78878) SPECIFICATION FOR NUCLEAR-GRADE MIXED OXIDES UO_2-PuO_2 COMPACTIBLE POWDER. H. J. Anderson and H. P. Wisely (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 9, 1963. Contract AT(45-1)-1350. 7p.

Specifications are presented for the physical and chemical characteristics of PuO_2-UO_2 particles which are to be fabricated into packed-particle fuel elements by the vibrational compaction process. Sampling, testing, test reports, and packing and marking are discussed. (D.L.C.)

12551 (HW-79845) METALLOGRAPHIC APPLICATION OF A THIN PLASTIC COATING ON RADIOACTIVE AND/OR CHEMICALLY ACTIVE MATERIALS: PLUTONIUM. G. E. Miller and T. K. Bierlein (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 1963. Contract AT(45-1)-1350. 8p.

The utility of using a thin, adherent plastic coating on metallographic specimens of plutonium was investigated. A plastic coating of formvar not only retards oxidation but also contains the contamination. In addition, it improves image resolution and contrast. The technique should be useful in the metallography of other materials which are toxic and/or have a high oxidation rate. It should also provide improvement in normal image contrast and resolution obtained in bright field metallographic work. (auth)

12552 (LAMS-3022) DEOXIDATION OF TANTALUM WITH SOME REACTIVE METALS. Ralph H. Perkins (Los Alamos Scientific Lab., N. Mex.). Nov. 1963. Contract W-7405-eng-36. 34p.

Several reactive metal systems were investigated as possible getters for the removal of oxygen from tantalum. Lithium proved to be unacceptable as a deoxidizing agent because of its high vapor pressure and its corrosiveness toward tantalum at temperatures of 800°C and higher. Calcium and calcium-magnesium (18 wt. % Mg) were more satisfactory as gettering agents; in 200 hours at 900°C they would reduce the oxygen levels in 0.20-in. diameter tantalum samples from several hundred parts per million to about 20 parts per million. However, the high vapor pressures of these metals at 900°C complicated their use. Cerium and cerium-cobalt alloy (12 wt. % Co) were also studied as possible gettering agents. The Ce–Co alloy was not satisfactory because of the formation of a layer of Ta_6Co_7 on the surface of the tantalum. Cerium proved to be the most satisfactory deoxidizing agent; at 900°C it has a very low vapor pressure, and it can also reduce the oxygen level in tantalum to about 20 ppm at this temperature in 200 hours exposure time. None of the getters lowered the oxygen content of tantalum below 15 ppm under the experimental conditions that were studied. (auth)

12553 (MCW-1482) PROCESS DEVELOPMENT QUARTERLY PROGRESS REPORT, JULY–SEPTEMBER 1963. (Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Mo.). Nov. 1, 1963. Contract W-14-108-eng-8. 47p.

The development and analysis of materials for use as nuclear fuels and related applications are summarized. Separate abstracts are reported for the five sections of the report. (N.W.R.)

For abstracts of individual sections see: 11966, 11967, 12646, 12647, and 12648.

12554 (NASA-TN-D-1944) AN INVESTIGATION OF A NEW NICKEL ALLOY STRENGTHENED BY DISPERSED THORIA. Charles R. Manning, Jr., Dick M. Royster, and David N. Braski (National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.). July 1963. 38p.

An experimental investigation was made to evaluate sheet material composed of a new nickel alloy strengthened by dispersed thoria, for aerospace applications in the temperature range from 1,800 to 2,400°F. Mechanical-property tests were made at room and at elevated temperatures from 1,700 to 2,570°F. The effect of preoxidation at various temperatures on the room-temperature tensile properties is also shown. One diffusion coating was evaluated to determine its effectiveness in reducing oxidation. Fabrication studies included machining, diffusion-bond joining, and several different welding processes. A description of the equipment and procedures utilized in performing the evaluation tests is also included. The metallurgical study included x-ray analysis and a microstructural examination of uncoated and coated sheet material. (auth)

12555 (NP-13615) THE EFFECTS OF SPACE ENVIRONMENTS ON INSULATION OF TEFLON TFE AND FEP RESINS. C. E. Jolley and J. C. Reed (Du Pont de Nemours (E. I.) & Co., Wilmington, Del.). 1962. 19p.

Data are presented on the changes in the physical and electrical properties of Teflon TFE and FEP resins during and after exposure to radiation and/or vacuum. It is concluded that TFE and FEP do not evaporate in vacuum, their radiation behavior is very sensitive to the presence of oxygen, both are radiation-resistant in the absence of oxygen, and the low-frequency loss properties of TFE but not FEP are affected by x rays. (D.L.C.)

12556 (NP-13629) IRON PLATING: AN ANNOTATED BIBLIOGRAPHY. Jack B. Goldmann, comp. (Lockheed Missiles and Space Co., Sunnyvale, Calif.). July 1963. Contract NOW62-0363. 94p. (SB-63-55)

This annotated bibliography of 240 references is concerned mainly with the electroplating of iron, and the alloy, iron nickel. Also, production methods for the deposition of heavy layers of iron and iron-nickel on stainless steel were emphasized. No reference is made to the production of thin magnetic films. Printed sources were examined for the years 1940 through June 1963. The arrangement of the bibliography is alphabetical by author. There are three indexes: (1) author, (2) corporate source, and (3) patent. (auth)

12557 (ORNL-TM-722) STRESS ANALYSES OF SPECIMENS FOR IN-PILE CREEP TESTS OF PARABOLIC GRAPHITE BEAMS. J. M. Corum (Oak Ridge National Lab., Tenn.). Feb. 1964. Contract W-7405-eng-26. 21p.

The irradiation-induced creep of graphite is being investigated in experiments that consist of loading parabolically shaped cantilever beams at the free end and measuring the resulting deflections with time. A series of stress analyses was made to verify the applicability of the elementary strength-of-materials approach for obtaining relations between stress and creep strain from the load-deflection data. The results of the analyses, which included a theory-of-elasticity solution, an evaluation of the effect of shear, and a bending analysis using an actual stress-strain diagram for graphite, show that an elementary strength-of-materials approach is adequate to predict the initial or elastic stresses. Preliminary results from the in-pile experiments indicate that the creep strains are linear with stress; thus, the initially linear

bending stress distribution given by the elementary theory remains unchanged during creep. (auth)

12558 (ORNL-TM-739) PROCUREMENT AND EVALUATION OF HARDWARE FOR THE BROOKHAVEN NATIONAL LABORATORY FUEL RODS. S. A. Rabin (Oak Ridge National Lab., Tenn.). Feb. 1964. Contract W-7405-eng-26. 55p.

A detailed evaluation of the hardware (nonfuel materials) procured for the Brookhaven National Laboratory fuel rods is presented. These fuel rods, which are being produced in the ORNL Kilorod Facility by the bulk oxide-vibratory compaction route, are to be used in criticality zero power experiments at BNL. The hardware includes: (1) Zircaloy-2 tubing for the cladding, (2) Zircaloy-2 bar for the end fittings, (3) aluminum oxide discs and Inconel X compression springs for fuel spacing, and (4) type 304 stainless steel bar for hanger fittings. Specifications for each of the components and supplementary specifications for the requisite nondestructive tests are appended. (auth)

12559 (TID-20150) LOW-TEMPERATURE SINTERING OF THORIUM OXIDE. Technical Report No. XIX. Alma U. Daniels and Milton E. Wadsworth (Utah. Univ., Salt Lake City. Inst. of Metals and Explosives Research). Jan. 31, 1963. For Oak Ridge National Lab., Tenn. Contract W-7405-eng-26, Subcontract 2176. 17p.

The sintering of thoria powder compacts was studied through isothermal shrinkage measurements made on ½ inch diameter pellets pressed at 86,500 psi from DT-58-EF-100 oxalate-precipitated thoria prepared by ORNL. Measurements were made at fifty degree intervals over the range 750°C to 900°C. Isothermal shrinkage was related to basic sintering theory to yield equations of the form $\Delta L/L_0 = [A]^n t^n$. In this study n was found to be .41 or ≈ .4 which corresponds to the equation first derived by Kingery and Berg for bulk diffusion with the grain boundary acting as a vacancy sink. The activation energy was determined using the shrinkages at a given time from the various isotherms, and was about 22 kilocalories per mole. Consistent deviations from the applied theory were observed at temperatures greater than 900°C. Changes in the sintering rate were observed for different compacting pressures, but a systematic determination of this effect was not made. (auth)

12560 (TID-20235) PRECIPITATION PHENOMENA IN CERAMICS: THE SYSTEM $BaTiO_3$–$CaTiO_3$. Annual Report. Robert C. DeVries and George S. Ansell (Rensselaer Polytechnic Inst., Troy, N. Y.). Feb. 1964. Contract AT(30-1)-3176. 4p.

The preparation of homogeneous solid solutions of $BaTiO_3$–$CaTiO_3$ is described with respect to precipitation problems involved. The effects of heat treatment are discussed with respect to structures obtained and preparation techniques. (N.W.R.)

12561 (UCRL-11009) ELECTRON MICROSCOPY OF THIN FOILS. G. Thomas (California. Univ., Berkeley. Lawrence Radiation Lab, and California. Univ., Berkeley). Oct. 18, 1963. Contract W-7405-eng-48. 73p. (CONF-356-9)

From 1963 American Society of Metals/Metals and Materials Show, Cleveland, Oct. 1963.

23rd National Convention of the Society for Nondestructive Testing.

A general discussion of the application of the theory of diffraction contrast to the study of defects in crystals is presented. Mention is also made of magnetic domain contrast. The defects considered are dislocations, dislocation loops, stacking faults, and precipitates and methods for determining the sense of lattice displacements are described. The reliability of electron microscopy in some studies of bulk properties is discussed. (auth)

12562 (X63-12299) RESEARCH ON REFRACTORY ALLOYS OF TUNGSTEN, TANTALUM, MOLYBDENUM, AND COLUMBIUM. Quarterly Progress Report No. 3. R. C. Westgren and V. R. Thompson (Crucible Steel Co. of America, Pittsburgh). Feb. 15, 1962. Contract AF33(616)-8135. 35p.

The double electrode process was satisfactorily used to melt two ingots of a nominally W:12Cb:0.1Zr:0.1C alloy. However, when the W–Ti–Zr–C alloy was melted, the titanium recovery was too low. The Ta:25W and Ta:12Mo alloys were successfully rolled to intermediate gage sheet when plasma heating was used. Because of the inadequacy of the protective coatings used, no satisfactory sheet product was obtained in the rolling experiments on the tungsten-rich alloys. Several alloys exhibited tensile strengths in excess of 60,000 psi at 3000°F; the highest strength, 67,000 psi, was obtained with the W:20Ta:12Mo alloy. On the basis of tensile properties at 3000°F, previously determined extrudability, and recent rolling experience, two of the following three alloys will be selected for further work: Ta:20W:12Mo, W:12Cb, and W:20Ta:12Mo. (auth)

12563 (EURAEC-192) NON-DESTRUCTIVE WELDING RESEARCH (RADIOGRAPHIC AND ULTRASONIC). Quarterly Report No. 1. (Röntgen Technische Dienst N. V., Rotterdam). Nov. 24, 1961. Work Performed under United States–Euratom Joint Research and Development Program. Contract 045/61/5 RDH. 32p. (A translation)

For radiographic testing, a test block has been constructed in which artificial deviations and natural defects in material can be induced at various levels. Preliminary gammagraphic tests have established that the coarsest inhomogeneities, both artificial and natural, are still vaguely discernible under the least favorable conditions, and thus the test block may be considered suitable for further research. To some extent, systems have already been developed for improving manual ultrasonic research. (auth)

12564 (NP-tr-1105) THE PREPARATION OF MICROAUTORADIOGRAPHS WITH METALLIC SPECIMENS. S. Wadewitz and A. Mueller. Translated by E. Wilson (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.), from Isotopen Tech., 2: 81-3(1962). 13p.

A report is made of the experience gained using the high-resolution stripping films K 102 and K 105 of the VEB Filmfabrik Agfa Wolfen with metallic specimens with Ag^{110}. Hints are given for the preparation of specimens, mounting, contact and stripping methods, developing, and optimum density. The dependence of the resolution on the pressure is examined and the peculiarities in the interpretation of results of the stripping method are examined. (auth)

12565 AECL PUSHES FOR LOWER REACTOR COSTS. Can. Chem. Process., 46: 40-2(July 1962).

Programs for reducing fuel fabrication costs by reducing the amount of zirconium alloy in the bundle, improving the alloy composition to gain strength, increasing the heat rating of zirconium-clad fuel elements for operation at higher temperatures, and adapting zirconium to organic-cooled reactors are discussed. (C.E.S.)

12566 NEW NUCLEAR MATERIALS INCLUDING NON-METALLIC FUELS. VOLUME II. Proceedings of the Conference Held by the International Atomic Energy Agency at Prague, 1-5 July 1963. (International Atomic Energy Agency, Vienna). Proceedings Series. Nov. 1963. 568p. (STI/PUB/77(Vol.II). $11.00; Sch 231,-; 66s.stg; F.fr.44,-; DM 38.50(IAEA).

A total of 29 papers are presented on a variety of topics, some of which are: carbides, graphite, oxide dispersion fuels, fuel elements, fabrication, BeO reflectors, etc. Separate abstracts were prepared for 15 of the papers; the other 14 papers were previously abstracted in NSA. (D.L.C.)

For abstracts of individual papers see: 12027, 12112, 12567, 12715, 12716, 12754, 12755, 13257, 13258, 13259, 13260, 13261, 13262, 13263, and 13264.

12567 ZIRCONIUM CARBIDE–URANIUM CARBIDE SOLID SOLUTIONS. G. A. Meerson, R. B. Kotel'nikov, S. N. Bashlykov, and N. S. Gaevskaya. p.19-32 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. II." Vienna, International Atomic Energy Agency, 1963. (In Russian)

The work described was done to compare the characteristics of specimens of ZrC–UC solid solutions with and without the addition of nickel, and also to compare such specimens with ZrC obtained under comparable conditions. The procedure for obtaining powdered solid solutions of carbides is described. Results are described of experiments on the hot pressing of specimens, on testing under compression in an argon atmosphere at 2000 to 2500°C, and on subsequent annealing in vacuo. The mechanical properties of the specimens are compared. (auth)

12568 REDKIE SHCHELOCHNYE METALLI (LITII, RUBIDII, I TSEZII) BIBLIOGRAFIYA. Rare Alkali Metals (Lithium, Rubidium, and Cesium) Bibliography. B. I. Kogan, E. G. Kal'zhanova, and L. B. Sal'tina, eds. Moscow, Publishing House of the Academy of Sciences, 1962. 330p.

A bibliography is presented on the geological distributions, prospecting methods, mineralogy, crystal chemistry, methods of analysis, and processing economics of lithium, cesium, and rubidium. (C.E.S.)

12569 EXTRACTION OF REFRACTORY METALS FROM THEIR HALIDES. Milo Pelc Hnilicka, Jr. (to National Research Corp.). British Patent 948,659. Feb. 5, 1964. Filed July 29, 1961.

An apparatus is designed for producing Zr and other refractory metals by reduction of their halides with a metal such as Mg. The apparatus is simple to operate and contains safety provisions for controlling the temperature of the reaction and thus assuring maximum purity of the product. The apparatus comprises a furnace chamber, a horizontally disposed retort mounted in the chamber, and a heat insulating partition dividing the space in the retort into horizontally spaced zones. In operation of the apparatus, the refractory metal halide is vaporized in one zone and passed to the other zone to react with Mg. The reaction temperature is controlled by various means, including furnace cooling, condensation of refractory metal halide vapors, etc. (D.L.C.)

12570 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF URANIUM AND PLUTONIUM MONOCARBIDES. Ronald George Sowden (to United Kingdom Atomic Energy Authority). British Patent 948,791. Feb. 5, 1964. Filed Dec. 2, 1960.

A method for producing UC and PuC–UC is described that consists of reacting uranium oxide or uranium oxide mixed with plutonium oxide with a stoichiometric proportion of carbon at 1500°C at less than 200 μ Hg pressure over the reactants and continuously removing the gaseous products. The oxide mixture of Pu and U was obtained by coprecipitation of the oxalate form. (R.E.U.)

12571 METHOD FOR THE PRODUCTION OF A MAGNESIUM KEY ALLOY CONTAINING THORIUM. Frank Pitts (to Magnesium Elektron Ltd.). German Patent 1,155,607. Oct. 10, 1963. Priority date Apr. 28, 1958, Great Britain.

The method described comprises the conversion of magnesium with thorium tetrahalide in the presence of a mixture of molten chlorides. Thorium tetrachloride is produced by chlorinating suspended thorium oxide in a melt of chlorides of alkaline and/or chlorides of alkaline earth. An amount of magnesium is added to the resulting mixture of salts that is essentially higher than the amount necessary for the reduction of the thorium tetrachloride to thorium. (Gmelin Inst)

12572 THE PRODUCTION OF GRAPHITE FREE FROM BORON. Ernst Weingaertner (to Deutsche Erdol AG). German Patent 1,159,404. Dec. 19, 1963. Filed Nov. 14, 1959.

A method for the production of high-purity graphite (10^{-7} parts boron to one part graphite) from natural graphite is described. The method comprises the steps of grinding the crude graphite with water to obtain a paste, of kneading the paste with lubricating oil, and of separating the mineral ingredients by washing with vapor condensate. The residue is freed from the lubricating oil with the help of an organic solvent that afterwards is removed. The resulting graphite is stirred with fluoric acid at a temperature of 50°C for about 4 hours, the stirred mixture is suspended with vapor condensate, and finally the graphite is separated from the fluid phase. (Gmelin Inst)

12573 RADIATION RESISTANT STEEL. Hans Joachim Kirschning (to Klockner-Werke AG). U. S. Patent 3,119,687. Jan. 28, 1964. Priority date Oct. 22, 1959, Germany.

A radiation-resistant steel suitable for reactor structures is described. A rare earth element is included in the steel at 0.0001 to 0.05%. (R.E.U.)

Corrosion

Refer also to abstracts 12314 and 13331.

12574 (APED-4364) THE EFFECT OF HEAT TREATMENT ON THE CORROSION AND HYDROGEN PICKUP BEHAVIOR OF A Zr–Sn–Nb ALLOY IN HIGH-TEMPERATURE WATER AND STEAM. D. L. Douglass (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.) and H. A. Fisch (General Electric Co. Lamp Metals and Components Dept., Cleveland). Sept. 6, 1963. 34p.

Heat treatment was shown to increase the rate of corrosion of Zr–2Sn–2Nb over that of the annealed condition, but the rate of hydrogen pickup as a function of total corrosion was found to be relatively insensitive to heat treatment. The effects of heat treatment were analyzed in terms of changes in: (1) alloy constitution; (2) composition of microconstituents; and (3) the metal texture and oxide orientation. Stereoscopic examination of oxide-film surfaces by electron microscopy revealed cracking both at grain boundaries and at interfaces between phases. Extensive and abrupt changes in film topography, which also were sites of film cracking, were observed. (auth)

12575 (GEAP-3726(Vol.3)) SODIUM MASS TRANSFER. II. SCREENING TEST DATA AND ANALYSIS. 3. CORROSION SAMPLE DATA. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). May 1962. Contract AT(04-3)-189. 198p.

A compilation is given of corrosion data for ~570 samples that were exposed prior to Dec. 31, 1961, to flowing sodium in six sodium mass transfer test loops. The loops and samples comprised 316 stainless steel, 2¼ Cr–1 Mo steel, and/or 5 Cr–½ Mo–½ Ti steel. Analysis reports are also presented for all the test runs reported. (D.L.C.)

12576 (GEAP-4089(Vol.I)(Paper 3)) AN INVESTIGATION OF ZIRCONIUM ALLOYS FOR RESISTANCE TO CARBON DIOXIDE CORROSION. W. A. Maxwell (General Nuclear Engineering Corp., Dunedin, Fla.). 54p.

An investigation was made of zirconium base alloys suitable for reactor core hardware in a CO_2-cooled, D_2O-moderated reactor. Commercially available alloys were investigated for times to 18,000 hours at temperatures from 800 to 1300°F. Sixty-five experimentally prepared binary alloys containing 26 addition elements at different contents were also investigated. Data are presented in condensed form and emphasis was placed on aspects of interest to the general problem of zirconium corrosion. Multiple rate transition behavior was found at 1050°F, while at 1150°F and above, rates were linear. The "order of merit" of the alloys containing various addition elements varied from temperature to temperature. Thermal cycling at times to 3000 hours had little effect on the more resistant alloys as did changes in pressure from atmospheric to 500 psi. Diffusion of oxygen into the metal was not found. Beta heat treatment improved the corrosion resistance of certain alloys. Both similarities and differences in behavior of the alloys in CO_2 as compared with behavior in oxygen were found. Rather high but acceptable corrosion rates at 1050°F for two year periods were determined for the commercial ½% Cu–½% Mo alloys and several of the experimental binary alloys in the dry (<10 ppm H_2O), carbon monoxide free, CO_2 employed. At 1150°F, exposures of several thousand hours were possible without excessive attack. Twelve beneficial alloying elements were identified. Four elements were shown to be deleterious in the compositions tested. (auth)

12577 (GEAP-4089(Vol.I)(Paper 6)) DEVELOPMENT OF IMPROVED ZIRCONIUM ALLOYS FOR USE IN SUPERHEATED WATER AND STEAM. D. Weinstein and F. C. Holtz (Illinois Inst. of Tech., Chicago. Armour Research Foundation). 35p.

A zirconium-base alloy with corrosion resistance and strength superior to zircaloy-2 in 680°F water and 750 to 900°F steam is being sought in a development program. Approximately 100 binary compositions were screened by corrosion testing in 680°F water and 750°F steam; selected compositions were exposed to 900°F steam. Data obtained from these studies indicated a number of highly promising bases for ternary alloy investigation. On the basis of 4800-hr tests, a number of ternary materials were found to satisfy the program objective for the 680°F water environment. The compositions are based on Zr–1 Sb, Zr–1 Cr, Zr–0.5 Nb, and Zr–0.5 Sn with small additions of Te, Ge, Cr, or Fe. Further, the hydrogen pickup characteristics of these alloys were improved over zircaloy-2, but acceptability on this basis remains to be demonstrated by mechanical property evaluation. For 3000-hr tests in 750°F steam, the alloys Zr–3Cr–1Fe, Zr–3Cr–0.25Te, and Zr–1V–1Fe were superior to zircaloy-2 on the basis of corrosion resistance and strength; however, hydrogen pickup properties were about the same as Zircaloy-2, which is considered excessively high. In 900°F steam, a few materials were greatly superior to Zircaloy-2 but weight gains were very high. (auth)

12578 (GEAP-4089(Vol.I)(Paper 7)) CORROSION RESISTANCE OF IMPROVED ZIRCONIUM ALLOYS IN HIGH-TEMPERATURE STEAM. Ulrich Roesler (Siemens-Schuckertwerke A. G., Erlangen, Germany). 29p.

The corrosion behavior of zirconium alloys is being investigated in superheated steam. Corrosion rates, oxide layers, and hydrogen embrittlement are studied. It was found that Zr–Nb alloys with about 0.5 to 2.5% Nb are considerably more corrosion resistant in steam above 400°C than Zircaloy-2 and Zircaloy-4. The corrosion rates of binary Zr–Nb alloys in the range of 0.5 to 1% Nb could be lowered to a general extent by several ternary alloying elements. The effectiveness of a ternary alloy was found to depend on the concentration level in some cases. (M.C.G.)

12579 (GEAP-4089(Vol.I)(Paper 8)) ZIRCONIUM ALLOY DESIGN FOR STEAM SERVICE. H. H. Klepfer (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.). 25p.

A program was initiated for the development of a zirconium-base alloy for use as nuclear fuel cladding for steam service. Specifications were derived for an acceptable alloy on the basis of considerations of neutron economy, cost, hydrogen embrittlement, corrosion resistance, fabricability, and strength. Thirty-one alloys were arc-melted, fabricated to sheet, and heat treated. Specimens for testing were cut from the sheet. Corrosion resistance at 300, 400, and 500°C, mechanical properties before and after corrosion exposure, and hydrogen take-up during corrosion will be measured. (M.C.G.)

12580 (GEAP-4089(Vol.II)(Paper 19)) SOLUTE DISTRIBUTION BETWEEN CORROSION FILMS AND ZIRCONIUM ALLOY SUBSTRATES. D. L. Douglass and M. E. Urata (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.). 23p.

Preliminary data are given for oxide film composition on several ternary zirconium alloys. The atom ratio of Zr/beta-stabilizing solute did not change appreciably from substrate to oxide and from thin to thick films. The ratio of Zr/Sn did change significantly, increasing from substrate to film and increasing from thin to thick films. The latter behavior may be due to selective oxidation of tin, the only element studied with appreciable solid solubility in alpha zirconium, although no concentration gradients of tin in the substrate were detected by microprobe analyses. The failure to detect a gradient might be due to experimental shortcomings of the analysis, which are described. Although significant changes in concentration of tin appeared to exist from alloy to alloy and from thin to thick films, it was not possible to apply the Wagner-Hauffe rules inasmuch as the alloys were corroding according to a linear rate law. The study indicated the type of measurements needed to make a rigorous analysis of oxidation behavior and served to point out limitations of the various methods. (auth)

12581 (HW-78186) DEVELOPMENT OF IMPROVED CORROSION-RESISTANT STAINLESS STEEL. Final Report. W. G. Renshaw (Allegheny Ludlum Steel Corp. Research Center, Brackenridge, Penna.). Oct. 23, 1962. For General Electric Co. Hanford Atomic Products Operation, Richland, Wash. Contracts AT(45-1)-1350 and DDR-124. 76p.

Materials with improved corrosion resistance are needed for use in processing equipment handling HNO_3–HF and other corrosive solutions. Investigations were conducted to evaluate special modifications of Types 309 and 310 and higher Cr and Ni alloys. The 0.02% carbon Type 310 Cb, 0.02% carbon Type 310, and all of the higher Cr–Ni alloys were found to have a much improved general corrosion resistance over Type 309. The 0.02% carbon Type 310 Cb is recommended since it is not attacked in weld heat affected zones. (D.L.C.)

12582 (MSAR-64-14) EFFECT OF HIGH-TEMPERATURE SODIUM ON AUSTENITIC AND FERRITIC STEELS. PHYSICAL PROPERTIES OF MATERIALS. Progress Report 41, January 1964. (MSA Research Corp., Callery, Penna.). Feb. 18, 1964. Contract AT(11-1)-765. 38p.

The research program was initiated for the purpose of determining the effects of high temperature reactor grade sodium, and normally anticipated contaminants, upon Type 316 stainless steel and 2¼ Cr–1 Mo steel. For comparison, the physical properties of these same materials were to be determined in air and helium. The test temperatures selected were 1200°F for the austenitic and 1100°F for the ferritic. The contaminants to be intentionally introduced into the sodium after the reactor grade sodium tests were completed are oxygen, carbon, and nitrogen. The types of test selected for revealing any possible effects of the environments upon the materials were tensile, creep, creep-to-rupture, and fatigue. Tests 1 and 2 were completed. The complexity of the Na–C–stainless steel system has delayed the specimen testing in Test 3 (type 316 stainless steel in 1200°F high-carbon sodium). The creep, creep-to-rupture, and fatigue tests in sodium were completed for Test 4 (2¼ Cr–1 Mo steel in 1100°F high-oxygen sodium). The creep tests show a lower creep rate in high-oxygen sodium as compared with low-oxygen sodium, but the creep rate is still higher than in air or helium. The creep-to-rupture tests show a shorter life in high-oxygen sodium, while the fatigue tests show no difference in fatigue life. Preliminary results indicate faster decarburization of 2¼ Cr–1 Mo steel in high-oxygen sodium. (D.L.C.)

12583 (AEC-tr-6328) COMPATIBILITY OF VARIOUS AUSTENITIC STEELS WITH MOLTEN SODIUM. L. Champeix, J. Sannier, R. Darras, W. Graff, and P. Juste. Translated for Oak Ridge National Lab., Tenn., from a paper presented at the "Colloquium of the European Society of Atomic Energy on Liquid Metals, Aix-en-Provence, Cadarache, September 30-October 2, 1963." 30p.

Methods were developed for the study of corrosion by circulating molten sodium and were applied to the case of 18/10 austenitic steels. The results obtained are discussed as a function of various parameters: grade of the steel, temperature, oxygen content of the sodium, surface treatment, welding, mechanical stress. In a general manner, these steels have an excellent resistance in sodium, when its oxygen content is controlled by a simple purification system of the "cold trap" type and when these are produced in such a manner as to prevent the particularly dangerous phenomena of cavitation, as demonstrated by the description of an example. (auth)

12584 ON THE OXIDATION OF ZIRCONIUM BY CARBON DIOXIDE. Jean-Paul Guerlet and Pierre Lehr (Centre d'Etudes de Chimie Metallurgique, Vitry-sur-Seine, France). Compt. Rend., 258: 930-3(Jan. 20, 1964). (In French)

The reactions of zirconium with carbon dioxide at temperatures between 600 and 850°C were studied. (tr-auth)

12585 THE DECREASE IN CURRENT DURING THE ANODIC OXIDATION OF ZIRCONIUM UNDER POTENTIOSTATIC OPERATING CONDITIONS. A. Ya. Shatalov, Yu. P. Gladkikh, and V. V. Malygin. Dokl. Akad. Nauk SSSR, 152: 657-60(Nov. 21, 1963). (In Russian)

On carrying out an anodic oxidation at constant potential, the current decreases with time and approaches a limiting value. An expression can be derived, where $d \ln i/d \ln t = -\gamma$. On plotting lg I ($\mu$A) versus lg t (sec), the slope of the decrease in current should depend on the fall in potential $\Delta\phi$ in the thick oxide film. The decrease in current was determined for the anodic oxidation of zirconium in ammonium borate, sulfuric acid, and caustic. The value of γ decreased from 0.595 at a potential of 0.40 to 0.166 volts at a potential of 7.14 volts in 1N sulfuric acid. A lot plot gave a series of straight lines. The value of γ was constant and always less than 1. The data could be represented by the empirical equation: $it^{\gamma} = \text{const} = k$. This equation is similar in form to the drop in current observed with passivated stainless steel. Values of k were found to be equal to 650 and 407 μA-sec/cm^2 for oxidation at voltages of 1.4 and 2.2 volts respectively. The thickness of the oxide film increased more rapidly, if there were no processes leading to the destruction of the oxide film. The current can be replaced by a reduced value for the current $\theta = i/\sigma i_0$, where σ is the surface roughness. If it is assumed that γ is constant, the drop in current takes the following form: $\theta t (\ln\theta)^2 = C$, where C is a new constant including γ. The calculated and experimental decreases in current were in good agreement. In 1N KOH solution, there was evidence for the partial dissolution of the oxide film with formation of a zirconate at a relatively high, positive oxidation potential. (TTT)

12586 PROTECTION OF MOLYBDENUM FROM OXIDATION BY MOLYBDENUM DISILICIDE BASED COATINGS. A. R. Cox and R. Brown (Royal Armament Research and Development Establishment, Fort Halstead, Eng.). J. Less-Common Metals, 6: 51-69(Jan. 1964).

Vapor-deposited molybdenum disilicide coatings on molybdenum prevented oxidation for 200 hr at 1450°C and similar ones were still protective after six months at 1000°C. This protection was reduced to three hours under thermal cycling between 1000 and 20°C. By adding either iron or chromium to the silicide the cyclic life was trebled, with no effect on the above resistance at 1000°C, though at 1450°C it was reduced to 20–80 hr. Failure in the thermal cycling test was due to cracks propagating through the coating, whereas failure under stable conditions occurred when the disilicide was replaced by the less oxidation-resistant silicides Mo_3Si and Mo_5Si_3. Maximum cycling resistance was obtained with silicide coatings approximately 30 μ thick, though for static conditions the thicker the coating the longer the life. The cycling resistance was unaffected either by the preparation of the molybdenum surface prior to the coating or by the coating structure, but lowering the preparation temperature improved it. (auth)

12587 ON ZrNb 1 PICKLING. H. Spindler and M. Mattmueller (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Kernenergie, 6: 679-85(Dec. 1963). (In German)

Experiments for determination of the optimal pickling conditions for the jacket material ZrNb 1 with regard to the chemical composition of the pickling bath, pickling temperature, and sample motion are described. The hydrofluoric acid concentration was determined at constant temperature in essentially the velocity of dissolution, for

the concentration had relatively little influence on nitric acid. The pickling bath is subject to strong exhaustion; therefore regular analytical control and regeneration is necessary. The possibility of the appearance of pickling errors in the pickling of mobile sheet samples is discussed. (tr-auth)

12588 KINETICS OF THE FORMATION OF ANODIC OXIDE FILMS ON TANTALUM. P. H. G. Draper and P. W. M. Jacobs (Imperial Coll. of Science and Tech., London). Trans. Faraday Soc., 59: 2888-98(Dec. 1963).

Theories of the growth of anodic oxide films are discussed and their predictions concerning the current and temperature-dependence of the field examined. New measurements of the mean field in (amorphous) Ta_2O_5 are used to test the predictions of the theories of oxide growth. Results obtained in 0.1 N H_2SO_4 and 100% H_2SO_4 as the forming electrolyte are consistent with both the single carrier-single barrier theories and the theory in which a compensating space charge for the moving metal ions is provided by immobile cation vacancies. Formations in 40% H_2SO_4 over a wider temperature range (150°C) showed, however, significant departure from the predictions of the above theories. Instead they agree with Dewald's theory in which the rate of movement of metal ions is controlled by activation barriers located both at the metal-oxide interface and within the film. (auth)

12589 RECENT STUDIES OF THE GROWTH AND BREAKDOWN OF OXIDE FILMS ON ZIRCONIUM AND ZIRCONIUM ALLOYS. J. N. Wanklyn (Atomic Energy Research Establishment, Harwell, Berks, Eng.). 33p. (CONF-187-63)

From American Nuclear Society Meeting, New York, Nov. 1963.

Studies were made on the effects of oxide contamination and film thickness on the growth and breakdown of oxide films on Zr and Zr alloys. Increasing evidence that freedom from breakdown in steam is associated with fast initial film growth was found. Both copper and unknown contamination due to annealing in silica capsules diminish localized breakdown. The results strengthened the idea that considerable, and sometimes quite long lasting, effects on film behavior can be produced by amounts of foreign elements too low to be detected by other means. (P.C.H.)

12590 PROCESS FOR PREVENTING OXIDATION OF NUCLEAR REACTOR COOLANT CHANNEL MAGNESIUM SHEATHS. Roger Caillat and Raymond Darras (to Commissariat à l'Energie Atomique). U. S. Patent 3,119,745. Jan. 28, 1964. Priority date Apr. 25, 1958, France.

A method is described for reducing oxidation of Mg sheaths containing fissile material that are subjected to an oxidizing atmosphere. The oxidizing atmosphere is bubbled through hydrogen fluoride, fluorinated methane, or ethane containing chlorine and trifluoromethyl benzene, and then is allowed to pass over the Mg sheath at 250 to 500°C. (R.E.U.)

Fabrication

Refer also to abstracts 12846 and 13246.

12591 (AD-409960) REFRACTORY ALLOY FOIL ROLLING DEVELOPMENT PROGRAM. Phase III Report, February 18, 1963–May 20, 1963. (Du Pont de Nemours (E. I.) & Co. Metals Center, Baltimore). Contract AF33(657)-8912. 56p.

The processing of three niobium-base alloys and two tantalum-base alloys from ingot to 0.100-in.-thick × 12-in.-wide sheet is described. The alloys were Nb–10% W–1%Zr–0.1%C (D-43), Nb–5%Mo–5%V–1%Zr (B-66), Nb–10%W–2–½%Zr (Cb–752), Ta–10%W, and Ta–8%W–2%Hf (T–111). The operations involved were: extrusion, hot rolling, conditioning, annealing, and cold-rolling. Rolling of small sheets of pure tungsten (0.060 in. thick and below) is described. (auth)

12592 (AD-410514) INVESTIGATION OF ULTRASONIC WELDING OF REFRACTORY METALS AND ALLOYS. Bimonthly Progress Report No. 5, April 16, 1963–June 15, 1963. (Aeroprojects, Inc., West Chester, Penna.). July 1963. Contract NOw 63-0125-c. 3p.

The necessity for moving the experimental welder and instruments into a new area precluded continuation of actual welding studies. The interruption of the experimental work provided time for the incorporation of modifications and improvements to the existing welding array. (auth)

12593 (AD-411155) COLUMBIUM ALLOY SHEET ROLLING PROGRAM. Interim Report No. 2, May 7, 1963–July 6, 1963. W. O. Gentry and H. A. Moreen (Fansteel Metallurgical Corp., North Chicago, Ill.). July 7, 1963. Contract NOw-63-0231-c. 7p.

Nominal 6-in. diameter by 300-lb ingots of FS-85 (Nb–27Ta–10W–1Zr) and B-66 (Nb–5V–5Mo–1Zr) were received and prepared for forging to sheet-bar. Inspection data as well as an outline of the further processing and evaluation of these materials are presented. (auth)

12594 (AD-427997) ULTRASONIC WELDING OF REFRACTORY METALS AND ALLOYS WITH POWER-FORCE PROGRAMMING. Final Report. Research Report No. 63-66. Nicholas Maropis and John G. Thomas (Aeroprojects, Inc., West Chester, Penna.). Dec. 1963. Contract NOw 63-0125-c. 114p.

Equipment was assembled for ultrasonic welding with power-force programming, to provide incremental changes in ultrasonic power and clamping force during a single weld interval. Preliminary welding of 2024-T3 aluminum alloy and Inconel X-750 showed significant weld strength improvement with power-force programming, which was selected without extensive experimentation. Significantly improved weld strengths and lower strength variability were obtained with power-force programmed welding of 0.010-inch and 0.013-inch molybdenum-0.5% titanium alloy and with 0.015-inch B-66 niobium alloy. (auth)

12595 (AD-429144) COLUMBIUM "H" SECTION PROGRAM. PHASE I. EXTRUSION. PHASE II. DRAWING. Interim Report II, October 1, 1963–January 1, 1964. E. V. Peterson (Du Pont de Nemours (E. I.) & Co. Metals Center, Baltimore). Contract AF33(657)-11293. 40p.

The development of the extrusion process for D-43 (Nb–10W–1Zr–0.1C) and Cb–752 (Nb–10W–2.5Zr) "H" sections continued. "H" extrusions (0.125 to 0.060 in. section thickness) showed reduced contamination and improved straightness, but surfaces and uniformity of section thickness were unsatisfactory. Extrusions were also drawn from section thickness of 0.188 in. at room temperature with reductions of 5 to 18% per pass. Total reductions up to 28% were made on short lengths without intermediate annealing. (auth)

12596 (CONF-187-84) DEVELOPMENT OF FUELED GRAPHITE CONTAINING PYROLYTIC-CARBON COATED CARBIDE PARTICLES FOR NONPURGED, GAS-COOLED REACTOR SYSTEMS. F. L. Carlsen, Jr., E. S. Bomar, and W. O. Harms, comp. (Oak Ridge National Lab., Tenn.). [1963]. Contract [W-7405-eng-26]. 58p.

From American Nuclear Society Meeting, New York, Nov. 1963.

Progress is reported in several areas of development of fueled graphite containing coated particles for nonpurged gas-cooled reactor systems. The sol-gel process has been modified for making spherical particles of both thorium–uranium carbide and thorium–uranium oxide suitable for coating. Equipment has been assembled and methods have been developed for deposition of pyrolytic-carbon coatings under well-controlled conditions. Damage to coated particles during fabrication into a graphite matrix depends on the molding pressure and the volumetric content of coated particles. Vendor-supplied coated particles and fueled graphite spheres have been evaluated extensively in both in- and out-of-reactor tests. Duplex- and triplex-coated particles have excellent fission-gas retention at 2050°F to burnups of 15 at. %, and one triplex sample has also shown good retention at 2500°F to 20 at. % burnup. Fueled graphite spheres containing coated particles have good irradiation performance, but the fission-gas release rates are somewhat higher than for unsupported coated particles. Fueled graphite spheres react with water vapor about as rapidly as do Speer Mod-2 and ATJ grades of graphite. The diffusion rates in pyrolytic carbon are the same for uranium, thorium, and protactinium. The diffusion rates in the direction parallel to the deposition plane are much higher than those in the perpendicular direction. (auth)

12597 (GEAP-4294) ECONOMIC COMPARISON OF FUEL FABRICATION PROCESSES USED IN THE HIGH POWER DENSITY PROGRAM. Robert B. Hoffman (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). June 25, 1963. Contract AT(04-3)-361. 33p.

The principal objectives of the Consumers High Power Density (HPD) Fuel Development Program are to demonstrate the performance of uranium dioxide and stainless steel clad fuel, at high power density conditions and to explore processes leading to reductions in fuel fabrication costs. The latter objective is discussed and economic comparisons are made of the different processes used in fabricating fuel rods for the Consumers HPD program at APED. The fabrication costs of processes actually used in producing fuel rods are evaluated and compared economically. These processes include pelletized fuel with pellet-to-clad gap (4 to 9 mil) and with gap reduced by swaging, and compacted powder fuel made by cold swaging, hot swaging, tandem rolling, and vibratory compaction. Time measurements of the labor involved in the different processes were made for the 2 and 3-pass, cold swaged powder process, and the reduced gap (swaged) pellet process using both ground and unground pellets. Many of the fabrication steps are common to all of the processes and the labor requirements are the same. In determining the cost of a process which contained one or more unmeasured steps, an estimate of the labor required was made based on fabrication experience in the laboratory. These types of estimates were made in the cases of the tandem rolling operation, the heating operation for hot swaging, and the rod filling operation for vibratory compaction. The results of the fabrication cost analysis for the various processes indicated that the tandem rolling process required the least amount of fabrication labor, followed by the swaged powder, vibratory compaction, and swaged pellet fuel processes, which were the most expensive. Tables are given of the various fuel fabrication processes and their relative fabrication labor requirements. (auth)

12598 (NAA-SR-Memo-9057) EVALUATION OF EXPERIMENTAL SAP930 ALLOYS. E. C. Supan and P. B. Ferry (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 6, 1963. Contract AT-11-1-GEN-8. 15p.

Aluminum-Industrie-Aktien-Gesellschaft (AIAG) is investigating processes for producing SAP alloys of low-gas content using a vacuum sintering operation. It is claimed that the material produced by vacuum sintering has a hydrogen content of less than 0.0010%. In one experimental process the powder is compacted and vacuum sintered for direct extrusion to tubing. In a second, advanced production process, the powder is compacted, vacuum sintered and then extruded to billet stock by the conventional SAP fabrication process. In a cooperative development effort between AIAG, AI and Torrance Brass Foundry (TBF), vacuum sintered billets were extruded as 14-fin tubing along with standard production SAP930 billets being processed on a development purchase order. Both sinter-pressed compacts and the advance production billets were successfully extruded; however the resultant tubing of each process was inferior to the standard production tubing. The dimensional control would probably be improved if additional billets were extruded. A metallographic evaluation revealed that the sinter-pressed material was greatly homogenized by the extrusion process. However, the microstructure was not as homogeneous as that of the multi-extruded advanced production material. Additional testing is necessary to determine the mechanical properties of these alloys. (auth)

12599 (NLCO-900) SUMMARY TECHNICAL REPORT [ON FEED MATERIALS] FOR THE PERIOD OCTOBER 1, 1963–DECEMBER 31, 1963. R. Burgett, ed. (National Lead Co. of Ohio, Cincinnati). Feb. 17, 1964. Contract AT(30-1)-1156. 58p.

Improvement of Production Furnace Induction Coil Assembly. An improved induction coil assembly was developed for the vacuum furnaces in which uranium is remelted and cast into ingots. More than 350 ingots have been cast in two furnaces fitted with the improved assemblies. No arcing between coil turns has been observed, and the higher thermal efficiency of the improved coil assemblies has made it possible to reduce the furnace power cycle. Vacuum Remelt Recovery of Ingot Crops. Uranium ingot crops, after being pickled in nitric acid and vacuum-remelted, were used as feed for the ingot casting operation. Fuel cores fabricated from ingots produced entirely from remelted ingot-crop metal were equal in quality to cores from ingots produced from conventional remelt charges. Measuring Remelt Pour Temperatures By Use of an Infrared Radiation Pyrometer. The pyrometer was used to control the furnace cycle for a test program in which eleven 1270-lb ingots were cast. The pyrometer was sighted on the crucible pour plug and then on the uranium pour stream as the ingot was cast. Multiple Beta Heat Treatment of HAPO Hollow Fuel Core Blanks. A study was made of the effects of multiple alpha-to-beta-to-alpha phase transformations on the dimensional stability of uranium fuel core blanks. After 1 to 30 cycles, although the core blanks underwent an increase in length and a decrease in diameter, no internal voids were produced. Induction Heat Treating of Hanford Hollow Fuel Cores. A large quantity of HAPO hollow cores was successfully beta heat treated by electrical induction and quenched in oil. The grain sizes and structures of these cores were finer and more uniform, respectively, from core to core than those of salt-heated, oil-quenched cores.

The Electrochemical Machining of Uranium. An off-site test was conducted to investigate the feasibility of machining uranium by electrochemical means. (D.L.C.)

12600 (NP-13628) FUSION WELDING OF ALUMINUM: AN ANNOTATED BIBLIOGRAPHY. Helen B. McCormick and Peter R. Stromer, comp. (Lockheed Missiles and Space Co., Sunnyvale, Calif.). July 1963. 26p. (SB-63-56)

This bibliography (62 references) has been compiled on the fusion welding of aluminum alloys with emphasis on references reporting the latest advances in the Tungsten-Inert-Gas process, using either alternating current or direct current straight polarity. Literature coverage is for the period 1962 through June 1963. Entries are arranged alphabetically by senior personal author or by journal article title when no author is given. A subject index is included. (auth)

12601 (RTD-TR-8-112) EXTRUDING AND DRAWING MOLYBDENUM TO COMPLEX THIN H-SECTION. Interim Technical Engineering Report No. 2, October 1, 1963–December 31, 1963. P. A. Santoli (Allegheny Ludlum Steel Corp. Research Center, Brackenridge, Penna.). Jan. 1964. Contract AF33(657)-11203. 16p.

Sixteen solid round extrusions of TZM were made primarily to determine suitable die materials. Reduction ratios at 45:1 and 55:1 were accomplished from a billet temperature range of 3000 to 3500°F. On the basis of good surface quality and dimensional runout on round extrusions, H-shaped dies will be prepared with .035-inch flame-sprayed zirconia as well as with pressed and sintered solid zirconia. Extrusion tooling performed well up to 237,000 psi liner pressure except for noticeable wear at the liner working surface. (auth)

12602 (Y-1450) A SURVEY OF HIGH-COMPRESSIVE-STRENGTH OXIDES AND CARBIDES. R. P. Levey, Jr. (Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.). Sept. 26, 1963. Contract W-7405-eng-26. 39p.

Composite, hard-grain, ductile matrix bodies of high compressive strength can be produced by isostatic pressing at 200,000 to 300,000 psi and firing at temperatures well below those normally employed for sintering comparable compositions. The compacts so produced are shown to have outstanding compressive strengths and steel-cutting ability. The preparation, pressing, firing, and testing of a number of such mixtures have been achieved. (auth)

12603 (AEC-tr-6312) VIBRATION AND VIBRATION-SWAGING FABRICATION OF NUCLEAR FUELS ENRICHED IN PLUTONIUM FOR WATER REACTORS. E. Fossoul and E. Vanden Bemden. Translated for Oak Ridge National Lab., Tenn., from Paper Presented at the Enlarged Colloquium Fuel Cycles for Power Reactors by the European Atomic Energy Commission, Baden-Baden, Sept. 9-14, 1963. 32p.

The results presented are part of a general study comprising 3 sections being developed simultaneously: (1) the study of the physical and neutronic parameters of UO_2–PuO_2–water lattices; (2) the fabrication of plutonium-enriched oxide fuels; and (3) the determination of the thermal properties of these fuels and their behavior under irradiation. The fuel fabrication methods selected, especially densification by vibration and vibration-swaging, are described. The basic types of elements fabricated for the first irradiation runs are reviewed. One of the major problems encountered when these two methods are used–homogeneity of the plutonium distribution in the elements–is examined in more detail. (auth)

12604 (FTD-TT-344) THE WORKING OF HEAT-RESISTANT ALLOYS. V. I. Dikushin, ed. Translation of "Obrabotka Zharoprochnykh Splavov" (a publication of the Publishing House of Academy of Sciences, U.S.S.R., Moscow, 1960). 380p.

A total of 30 papers is included which were presented at the conference held on Dec. 18 to 21, 1957, by the Machine Construction Institute of the Acad. Sci., USSR. They cover the casting, pressure working, welding, and cutting of heat-resistant alloys. (D.L.C.)

12605 (JPRS-23121) COLD- AND HOT-WORKING OF REFRACTORY METALS. Translation of articles from Dokl. Akad. Nauk SSSR, 152: 1086-8(Oct. 11, 1963) and Izv. Vysshikh Uchebn. Zavedenii, Chernaya Met., No. 9, 88-91(Sept. 1963). 13p. (OTS-64-21508)

Two papers are presented on the effects of cold working in vacuum on the electron work function of Mo and Ta and on the high-temperature deformation of refractory metals. A separate abstract was prepared for one of the papers; the other paper was previously abstracted in NSA. (D.L.C.)

For abstract of individual paper see: 12606.

12606 (JPRS-23121(p.6-12)) HIGH-TEMPERATURE DEFORMATION OF REFRACTORY METALS. V. L. Orzhekhovskii (Orzhekhovskiy), I. M. Pavlov, Ya. B. Gurevich, and A. E. (Ye.) Shelest. Translated from Izv. Vysshikh Uchebn. Zavedenii, Chernaya Met., No. 9, 88-91(Sept. 1963).

The rolling and coiling of technically pure Mo, Nb, and Ti were investigated at 800 to 1200°C. The problems of oxidation and saturation with gases during the high-temperature pressure treatment are discussed. It is shown that the treatment in vacuum results in improved properties due to purification of the metal. (D.L.C.)

12607 A LATHE SWARF COLLECTOR FOR USE WITH RADIOACTIVE MATERIALS. J. D. H. Hughes (Wantage Research Lab., Berks, Eng.). Intern. J. Appl. Radiation Isotopes, 14: 626-7(Dec. 1963).

A simple swarf collector that effectively prevents the escape of radioactive debris without enclosing the whole lathe is described. The device makes decontamination easy when it is necessary to prevent cross-contamination between samples. The device was designed primarily for the preparation of mounted specimens for autoradiography, but is also suitable for the quantitative collection of turnings for analysis as required in diffusion. (P.C.H.)

12608 URANIUM DIOXIDE PRECIPITATION IN ALKALI CHLORIDE FUSES AND ITS PROPERTIES IN PRODUCTION OF SWAGED UO_2 FUEL ELEMENTS. D. Naumann, W. Heyne, G. Tschirne, and W. Burk (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Kernenergie, 6: 691-3 (Dec. 1963). (In German)

By reductive precipitation with CO, a dense coarse-grained UO_2 powder was obtained from a solution of UO_2Cl_2 in alkali chloride melts. Likewise, UO_2 powder can be precipitated from a UCl_4 solution in alkali chloride melts by hydrolysis under suitable conditions. With powder samples, which were prepared according to both methods, molded bodies with a density of 89% theoretical were prepared by cold-forging in steel tubes. The UO_2 precipitation from alkali chloride melts proved promising for the preparation of UO_2 powder, which is case hardened by swaging. (tr-auth)

12609 KNOWLEDGE OF HOW TO MACHINE HARD-TO-MACHINE REFRACTORY METALS IS WIDENING DESIGN POTENTIALS FOR COLUMBIUM, MOLYBDENUM, TANTALUM, TUNGSTEN. PART II. HOW TO

MACHINE COLUMBIUM AND ITS ALLOYS. S.A.E. Journal, 71: 98-101(Sept. 1963).

Specific recommendations for turning, milling, reaming, tapping, and grinding Nb alloys are given. Physical and mechanical properties of Nb (at room temperature) that influence its machinability are tabulated. The results of machining 80 Nb–10 Mo–10 Ti are given. (P.C.H.)

12610 CERAMIC EXTRUSION OF REFRACTORY METALS. C. W. Funk and R. L. Landingham (Aerojet-General Nucleonics, [San Ramon, Calif.]). 12p. (CONF-373-3; AGN-TP-52)

From Technical Conference on Applied Aspects of Refractory Metals, Los Angeles, Dec. 1963.

A process for the ceramic extrusion of refractory metals is described. The process is ideally suited to the production of long, slender tubes of complex cross sections. Metals, oxides, or carbides, in either single or duplex microstructures, can be used. Applications of the extruded products are discussed. (P.C.H.)

12611 FINNED TUBES. Alan Carter (to Imperial Chemical Industries Ltd.). British Patent 947,327. Jan. 22, 1964. Filed Mar. 16, 1961.

A helically finned tube and a method of making the tube are patented. A tube having fins parallel to the tube axis is gripped at a number of points along its length and twisted in different directions about the axis of the tube. The twisting is performed while the tube material is relatively plastic just after extruding or heating. The fins of the resulting tube form helical paths having at least one change of hand. The helicity of the fins may also be different. Longitudinal secondary fins or "splitters" may be inserted through narrow slots in the helical fins and may also be made helical by further twisting. The tubes are designed for nuclear fuel cans. The varying helicity should increase the turbulence in the flow of coolant between the fins and therefore improve the heat transfer, and the change in direction of the helicity should equalize thrust on the splitters, thereby reducing vibration. (M.P.G.)

12612 IMPROVEMENTS RELATING TO THE CLOSURE OF PIPES. (to Societa per l'Esercizio dell'Instituto Sperimentale dei Metalli Leggeri). British Patent 947,558. Jan. 22, 1964. Priority date May 30, 1961, Italy.

A method and apparatus for closing the ends of sintered metal tubes are patented. The invention pertains particularly to thin-walled pipes of sintered Al containing considerable amounts of Al_2O_3, which may be used for reactor-fuel-element sheaths. A cup-shaped plug is inserted in the pipe, and the plug and pipe are heated and rotated by means of a steel ring surrounding the pipe. The plug is pressed against the inside wall of the pipe by a mandrel pressing against the inside wall of the plug, and the surfaces become welded to each other. The design of the steel ring and the mandrel are described. (M.P.G.)

12613 DIES FOR THE MANUFACTURE OF ARTICLES HAVING CONTOURED SURFACES. Clive Frederick George Dupen (to Nuclear Power Plant Co. Ltd.). British Patent 947,878. Jan. 29, 1964. Filed Nov. 9, 1960.

The design of a die used in the manufacture of finned containers for reactor fuel elements is patented. The die consists of many flat plates held face to face and arranged in separate assemblies, which are brought together to form the die. The assembled plates form a bore for holding a workpiece whose outer surface is to be shaped by the die, the edges of the plates being contoured to give the desired configuration to the workpiece. The die is specifically designed for forming a finned surface on a cylindrical container, the fins being at an angle to the longitudinal axis of the container. The plates in each assembly of the die are arranged in the same direction as that required for the fins and are bolted together by bolts perpendicular to the plates. (M.P.G.)

12614 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF SINTERED PLUTONIUM DIOXIDE. Lewis Eric Russell (to United Kingdom Atomic Energy Authority). British Patent 948,948. Feb. 5, 1964. Filed Apr. 27, 1961.

A method is described for the sintering of a compacted body of PuO_2 and Fe_2O_3 to produce a density of 95% (of theoretical). The iron oxide is characteristically included at 0.05 to 2.0 wt %. Temperatures range from 1400 to 1650°C. (R.E.U.)

12615 IMPROVEMENTS RELATING TO THE BONDING OF METAL CLADDING. Robert William Jackson Vivers (to United Kingdom Atomic Energy Authority). British Patent 949,107. Feb. 12, 1964. Filed Nov. 28, 1961.

A method of bonding a ferrous metal cladding to a ferrous cermet body is described. The method comprises electrolytic deposition of a nickel coating directly on the cermet, deposition of copper or copper base alloy as braze metal over the nickel, insertion of the compositely coated body into a metal sheath, hot swaging the assembly of the body and sheath at a temperature below the fusion of the braze metal, and then heat treatment of the assembly to fuse the braze metal at the interface of the body and sheath. (R.E.U.)

12616 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL. (to General Dynamics Corp.). British Patent 949,727. Feb. 19, 1964. Priority date Sept. 30, 1960, United States.

A method is given for fabricating ceramic fuel bodies which have a high structural strength and increased thermal conductivity, density, and resistance to fission product migration at high temperatures up to 2500°F. The method comprises combining ceramic fuel of average particle size of at least 150 microns with a refractory material to form a fuel body, and sintering the body. The fuel may be an oxide, carbide, or silicide, but the refractory material is preferably of the same class, e.g., an oxide when a fuel oxide is used. In the case of fuel oxides, the refractory material is preferably Al_2O_3 and/or BeO. The combining of the fuel with the refractory material may be carried out by either dispersing the fuel in a matrix of the material or coating the fuel with a film of the material. Several examples of the method are given using UO_2. (D.L.C.)

12617 IMPROVEMENTS IN OR RELATING TO URANIUM–MOLYBDENUM ALLOYS. Jeanne Lehmann and Henri Emile Ollier (to Commissariat a l'Energie Atomique). British Patent 950,163. Feb. 19, 1964. Priority date July 21, 1961.

A process for preparing a Mo–U alloy that has better properties than uranium itself for use as a fuel in a nuclear reactor is described. The two metals are melted under vacuum in a graphite crucible covered with a reducing cement. The product is maintained in a molten state and poured into molds in the form of bars or tubes. These are subjected to heat treatment in salt baths followed by a stepped tempering to produce a microstructure with grains of 60 to 80 μ. The Mo–U alloy is characterized by a Mo content of between 0.3 and 0.6% by weight. (M.C.G.)

12618 APPLICATION OF NICKEL ALLOYS FOR OBJECTS WHICH ARE LIKEWISE RESISTANT TO OXIDATION AND CORROSION RESISTANT TO MOLTEN SALTS AT HIGH TEMPERATURES. Henry Inouye, William Donald Manly, and Thomas Kirby Roche (to U. S. Atomic Energy Commission). German Patent 1,154,644. Sept. 19, 1963. Priority date Mar. 3, 1958, United States.

The nickel alloys applied are composed of 15 to 22% molybdenum, 6 to 8% chromium, 0.02 to 0.5% carbon, 0 to less than 6% iron, 0 to 4% vanadium, niobium, tantalum and/or tungsten. Means for the desulphurization, desoxidization, and the improvement of the forging and rolling properties are included. (Gmelin Inst)

12619 METHOD FOR ENCASING NUCLEAR FUEL ELEMENTS. Jacques André Stohr and Claude Bridoux (to Commissariat à l'Énergie Atomique). German Patent 1,159,105. Dec. 12, 1963. Priority date Oct. 18, 1960, France.

A method for encasing nuclear fuel elements with a sheath of sintered materials is described. The method comprises the steps of inserting a concavely shaped plug into the open end of the sheath, of welding the sheath, the inserted plug, and the convexly shaped counter plug simultaneously, and of removing the counter plug by machine working. (Gmelin Inst)

Properties and Structure

12620 (AD-404033) THERMODYNAMICS OF ALLOYS (CALORIMETRY). Final Technical Report, December 1, 1961–November 30, 1962. J. N. Pratt and A. W. H. Morris (Birmingham. Univ., England). Contract DA-91-591-EUC-2029. 16p.

The method of tin-solution calorimetry is used for the study of the thermodynamic properties of rare earth alloys. Details of the design and construction of the calorimeter were given previously, but some modifications were made because of the large heat effects encountered in the present experiments. Preliminary studies were made of the heats of solution, in liquid tin at 630°K, of pure cerium and lanthanum. Values of $\Delta\overline{H}_{Ce} = -69{,}500$ (mean deviation 900) cal/g atom Ce and $\Delta\overline{H}_{La} = -68{,}200$ (mean deviation 750) cal/g atom La, corresponding to infinite dilution values, were obtained. The validity and significance of the results are discussed, and plans for future work are outlined. (auth)

12621 (ARF-A6003) HIGH-TEMPERATURE PROPERTY STUDY FOR REENTERING NAP SYSTEMS. Final Report. J. C. Hedge, J. I. Lang, E. Howe, and R. Elliott (Illinois Inst. of Tech., Chicago. Armour Research Foundation). June 1963. Contract AF29(601)-5012. 99p. (AFSWC-TDR-63-17; AD-412586)

The experimental determination of the properties of hydrided zirconium-uranium alloy is part of a larger program entitled "Nuclear Auxiliary Power System Re-entry and Disposal Phenomena:" The following properties were determined over the temperature range from room temperature to 3260°R: linear thermal-expansion, thermal conductivity, specific heat, heat of fusion, heat of combustion, total normal emissivity, tensile strength, rate of hydrogen loss, rate of oxidation, and loss of fuel integrity at high heat flux. Rate of oxidation studies showed that when a hydrided zirconium-uranium alloy specimen was exposed to a temperature of 3010°R in a furnace containing an air atmosphere, the specimen developed large fissures and broke into several smaller pieces. However, an actual hydrided zirconium-uranium fuel element rod exposed to a somewhat higher heat flux in an inert atmosphere developed several large cracks but did not break into smaller pieces. (auth)

12622 (ASD-TDR-62-354(Pt.II)) WORK-HARDENING MECHANISMS IN BODY-CENTERED-CUBIC METALS. Donald P. Gregory (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). Mar. 1963. Contract AF33(616)-7855. 48p. (AD-411124)

This report presents results of a continued study of work hardening mechanisms in niobium and tungsten at low temperatures, preliminary studies of their alloys at elevated temperatures, and a literature survey of the deformation of body-centered cubic metals. (auth)

12623 (ASD-TDR-63-204) SOLID-SOLUBILITY LIMITS OF Y AND Sc IN THE ELEMENTS W, Ta, Mo, AND Cr. A. Taylor (Westinghouse Electric Corp. Research Labs., Pittsburgh). Apr. 1963. Contract AF33(616)-8315. 36p. (AD-409434)

Alloys and diffusion couples of yttrium and scandium with Nb, Ta, Cr, Mo, and W were examined by optical microscopy, x-ray diffraction, and mass spectrometry. The results indicate that the solid solubility of Y and Sc in these elements is less than 1 ppm. This is in conformity with the Hume-Rothery Rule that only a very restricted range of solid solution can be expected when the atomic diameter of solvent and solute differ by more than 14 to 15%. (auth)

12624 (ASD-TDR-63-270(Pt.IV)) MATERIALS INVESTIGATION, SPUR PROGRAM. PART IV. FATIGUE EVALUATION OF Cb + 1 W/O Zr. R. Salley and E. Kovacevich (Garrett Corp. AiResearch Mfg. Div. of Arizona, Phoenix). Oct. 31, 1963. Contract AF33(657)-8954. 15p.

The results of the cantilever fatigue properties of niobium–zirconium (1 wt %) alloy are presented. Tests were conducted in 800°F liquid potassium and 1600°F liquid lithium to determine the fatigue properties. The tests resulted in no serious contamination of the test material, and endurance limits for the test conditions were established. (auth)

12625 (AWRE-O-97/63) INCREASED DUCTILITY OF POLYCRYSTALLINE BERYLLIUM ABOVE 300°C RELATED TO TEST ENVIRONMENT. F. Morrow and A. Moore (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Dec. 1963. 21p.

The tensile properties of both commercially pure and SR quality beryllium between 300 and 450°C are affected by an aging process which occurs at 575°C and by the environment of the specimen during testing. Using Hounsfield No. 13 specimens, ductilities can be varied from 40 to 60% to >110% by testing the overaged specimens in air and in Cerrobend respectively; the limits of proportionality and ultimate tensile strengths are unaffected by the changes in test conditions. The observed changes in ductility were found to be dependent on the rate of strain and independent of heating rate and time at test temperature. A model is proposed to explain the changes in ductility based on the retardation of crack growth by either changes in the surface energy of the crack or changes in the radius at the root of the crack. (auth)

12626 (BM-RI-6375) SOME PHYSICAL PROPERTIES OF CERIA POWDERS DERIVED FROM FIVE SALTS. Louis P. Domigues, Roy L. Wilfong, and LeRoy R. Furlong (Bureau of Mines (College Park Metallurgy Research Center, Md.). July 1963. 13p.

The bulk and apparent densities, particle size, and sur-

face area of ceria powders derived from the ammonium sulfate, carbonate, nitrate, oxalate, and sulfate salts and heated at 950 to 1,500°C for 1 to 24 hours were studied. The bulk and apparent densities and particle size generally increased, and surface area decreased with increase in temperature and time of heating; surface area was more sensitive to changes in temperature and time than the other properties studied. These properties of the ceria powders had a marked dependence on temperature and a lesser dependence on duration of heating at a given temperature, and the source of oxide and thermal treatment cannot be considered optional in the preparation of refractory powders by thermal decomposition. The ammonium sulfate and sulfate salts heated at 950 and 1,200°C produced oxide powders with the lowest bulk density, the smallest particle size, and the highest surface area. The highest apparent densities were achieved for oxides resulting from the carbonate and the sulfate but the carbonate-derived material was considerably coarser. The surface areas of ceria powders derived from cerium salts decrease in the order of sulfate, ammonium sulfate, nitrate, oxalate, and carbonate. The observation of these physical properties is useful in predicting the sintering behavior of various oxide powders. (auth)

12627 (BNL-823(p.66-93)) METALLURGY DIVISION. D. H. Gurinsky (Brookhaven National Lab., Upton, N. Y.).

Thirteen natural circulation boiling Hg loops are under test. A Ta loop is still operating after 6300 hr. Severe corrosion was observed in the superheater of a pre-inhibited carbon steel–Hg loop. Fabrication of a forced circulation Nb–1 Zr boiling loop was started. Capsule studies of the factors relating to the previous Hg–Nb–1 Zr loop failure were made. A scheduled 5000-hr run was completed satisfactorily on the second Nb–1 Zr boiling Na loop, and no corrosion or mass transfer was observed. Post-operation examination of Nb–1 Zr Na reflux capsules was completed. A solubility apparatus for handling Na at 1100 to 1300°C is being fabricated. The first large-boiling Na loop is being started. The irradiation of all HFBR test fuel elements was completed. The Dy_2O_3 stainless steel coupon will have its designed dose of 2×10^{21} nvt in September. Both time of experiment and current density have an effect on the electric mobility of Ag in Bi. Electrical resistivity measurements of Bi and Ag–Bi alloys were initiated. The emf measurements on liquid metal cells (related to electrodiffusion phenomena) were obtained. A quartz mass transfer rate loop was constructed. Preliminary data on the solubility of Co in Hg were obtained. A relationship is proposed between the solubility of a metal in a liquid metal and the interfacial energy between solid and liquid metals. Vacuum-evaporated films can be prepared and their thickness determined from 45 to 1000 Å. The presence of W, Pd, or Cr atoms in or on Li^6F films permits appreciable numbers of long fission tracks to be observed in the electron microscope, whereas they are invisible in the absence of these heavy atoms. Preliminary data were obtained on the thermodynamics of formation of Th–C systems by a solid electrochemical cell technique. An apparatus for growing single crystals of Fe by the strain-anneal technique was built. The in-pile furnace for irradiation of pure Fe and alloy specimens is ready for operation. Data were obtained on irradiated and unirradiated Fe–Mn–C and Fe–Ni–C alloys. Irradiation of pure Fe to 2×10^{20} nvt caused an apparent recovery in the yield stress. An apparatus was built to grind remotely slices of pure Fe thinner than they were originally sliced by an electromagnetic spark discharge. Specimens so produced were found to be virtually free from dislocations after electropolishing. No observable dislocation or substructure was observed in a specimen so treated after 1.2×10^{20} nvt in the MTR. The average net recovery of growth in BGRR graphite samples since June 1962 is 145%. The switch from a 3 to a 6-week annealing cycle interrupted this recovery. Stored energy was greatly reduced by the periodic annealing. Compressive strength of irradiated graphite was in all BGRR samples greater than that of virgin graphite. Damage to the C-axis of BGRR graphite was lowest in the lower flux higher temperature areas near the core perimeter. Radiation annealing of graphite was more effective in removing damage than thermal annealing alone. The irradiations of specimens involve competitive reaction between production and decomposition of interstitial complexes. The correlation in radiation effects on C-axis, stored energy, and dimensional change in graphite suggested that all the measurements reflect changes in total defect concentrations. The interstitial formed during the first irradiation was concluded to be more stable than are the clusters formed during annealing the graphite. Decomposition of C_8Cs occurs in 3 stages, the first two controlled by reactions at the graphite-vacuum interface, and the third by diffusion of Cs through the graphite. The x-ray parameter variance of ZrC with 1% C suggests that carbon sites below stoichiometry are vacant. Xe can be introduced into ZrC powders by recoil from a surrounding (soluble) uranium salt under irradiation, or by allowing the ZrC with ~1% UC (in solid solution) and irradiating. A Kr absorption apparatus for measuring low surface areas was constructed. X-ray data for $ZrC_{1.155}$ were obtained up to 2450°C, and expansion coefficients derived. The carbide was prepared by arc melting Zr with C. It contained ZrC plus excess graphite. No phase change was observed in ZrC at 2200°C. Lattice parameter data were obtained on Re up to 2800°C. (auth)

12628 (CONF-340-14) DIFFUSION AND CREEP IN BERYLLIUM OXIDE. S. B. Austerman (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.) and R. Chang (North American Aviation, Inc. Science Center, Canoga Park, Calif.). [1963]. Contract [AT(11-1)-Gen-8]. 9p.

From American Physical Society 1963 Autumn Meeting, Chicago, Oct. 1963.

The evidence for a relationship between creep and diffusion in BeO is examined. It is concluded that the steady-state creep of polycrystalline BeO is controlled by the lattice diffusion of the Be ions. The O ions probably diffuse along the grain boundaries and hence are not the rate-controlling species. The interpretation of the Be diffusion in BeO in terms of vacancies and impurities is considered. (D.L.C.)

12629 (DMIC-191) THE ENGINEERING PROPERTIES OF TUNGSTEN AND TUNGSTEN ALLOYS. F. F. Schmidt and H. R. Ogden (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Sept. 27, 1963. Contract AF33(616)-7747. 133p. (AD-425547)

Results are presented of a state-of-the-art survey covering tungsten and ten of its alloys. All data are given in tabular and graphical form covering some of the more important physical, mechanical, and metallurgical properties for each material. References are given at the conclusion of each material section. (auth)

12630 (DS-106) POLYTETRAFLUOROETHYLENE PLASTICS. Data Sheets. Emil Schafer (Hughes Aircraft Co. Electronics Properties Information Center, Culver

City, Calif.). June 1962. Contract AF33(616)-8438. 37p. (AD-413907)

Data are presented on the properties of polytetrafluoroethylene plastics as an insulator. The properties include arc resistance, corona effects, dielectric constant, dielectric strength, dissipation factor, insulation resistance, surface resistivity, and volume resistivity. The data are in the form of curves and tables. A bibliography of 22 references is included. (D.L.C.)

12631 (DS-127) SILICONE RUBBER. Data Sheets. John T. Milek (Hughes Aircraft Co. Electronics Properties Information Center, Culver City, Calif.). June 1963. Contract AF33(616)-8438. 59p. (AD-413906)

Data are presented on the properties of unfilled and filled silicone rubber as an insulator. The properties include dielectric constant, dielectric strength, dissipation factor, electrical resistivity, and power factor. The data are in the form of curves and histograms. A bibliography of 68 references is included. (D.L.C.)

12632 (GEAP-4089(Vol.I)(Paper 2)) THE DEVELOPMENT OF ZIRCONIUM ALLOYS FOR PRESSURE TUBES IN WATER-COOLED POWER REACTORS. W. R. Thomas (Atomic Energy of Canada Ltd., Chalk River, Ont.). 13p.

The history of pressure tube development is sketched and the development of zirconium alloys for use as pressure tube material is reviewed. It is indicated that the Zircaloys have reached the limit of their capabilities in this application and the investigations being carried out to develop stronger zirconium alloys are described. A hot stress tube operating at design stress of 25000 psi at 300°C appeared feasible. It was concluded that as coolant temperatures increase above 350°C, it will be necessary to adopt a cold stress tube design. (M.C.G.)

12633 (GEAP-4089(Vol.I)(Paper 4)) DEVELOPMENT OF Zr-Nb-Sn ALLOYS FOR REACTOR APPLICATIONS. H. Richter and J. C. Tverberg. 56p.

Binary phase diagrams were determined for the zirconium-niobium system at two different oxygen contents. Each diagram showed a definite ternary characteristic due to the oxygen content of the zirconium. Ternary phase diagrams were also developed for the systems zirconium-niobium-hydrogen and zirconium-niobium-tin. The latter system showed an extremely sluggish transformation rate. It was found that the corrosion behavior of the zirconium-niobium alloys was very strongly dependent on the heat treatment, with the optimum temperature for heat treatment being 580°C. An alloy with good properties was developed; its composition was Zr + 3Nb + 1Sn. This alloy had corrosion properties equal to those of Zircaloy-2 and strength and creep properties superior to Zircaloy-2. This alloy is readily welded and can be fabricated into tubes of the sizes required for reactor use. The hydrogen pick-up was found to be less in this alloy than in Zircaloy-2 and the impact strength much better. (auth)

12634 (GEAP-4089(Vol.I)(Paper 5)) RESEARCH ON ALPHA-ACTIVE EUTECTOID ZIRCONIUM ALLOYS. R. P. Syre (Compagnie Pechiney, Chambery, France). 11p.

A research program is being carried out to develop a zirconium alloy possessing good mechanical properties over a temperature range from 300 to 700°C. An alpha-dispersoid zirconium base alloy is being developed. A range of binary alloys containing various amounts of a betagenic element is being studied to single out two or three of the most favorable combinations of composition. (M.C.G.)

12635 (GEAP-4089(Vol.I)(Paper 9)) THE DETERMINATION OF THE EQUILIBRIUM PHASE DIAGRAM, ZIRCONIUM-NIOBIUM. C. E. Lundin and R. H. Cox (Denver. Univ. Denver Research Inst.). 30p.

The zirconium-niobium system was systematically investigated to establish the equilibrium phase diagram from 0 to 100% of alloy addition. The phase equilibria were determined by metallographic techniques with the auxiliary aid of hardness determinations and incipient-melting techniques. A minimum in the liquidus-solidus boundaries occurred at 22 wt % niobium and 1740°C. Complete solid solubility existed above 970°C in the body-centered cubic phase. A monotectoid reaction existed at 20 wt % niobium and 610°C. Solid solubilities at the monotectoid level were 0.6 and 85 wt % niobium, respectively. (auth)

12636 (GEAP-4089(Vol.I)(Paper 10)) TRANSFORMATIONS IN ZIRCONIUM-NIOBIUM ALLOYS. R. F. Hehemann (Case Inst. of Tech., Cleveland). 45p.

Time-temperature-transformation diagrams are presented for the isothermal decomposition of beta in zirconium alloys containing 12, 17.5, and 25% niobium. Transformation occurred by fundamentally different mechanisms at high and low reaction temperatures. A cellular reaction, analogous to the discontinuous precipitation in many age hardening systems, was observed in the hypermonotectoid 25% Nb alloy but could not be detected in the 12 or 17.5% Nb alloy. The direct precipitation of alpha from beta dominated the high temperature decomposition of the latter alloys. This direct precipitation of alpha also occurred in the 25% alloy at temperatures in the range 475 to 575°C. Here, it competed with the cellular mechanism. Decomposition of beta at temperatures below 450°C involved the formation of the omega phase characteristic of many beta stabilized titanium and zirconium alloys. This phase can form in either a diffusionless or a diffusion controlled manner. The temperature for initiation of the diffusionless transformation during cooling was determined and found to decrease with increasing niobium content of the alloy. This diffusionless formation of omega appeared to take place reversibly and was intimately associated with a negative temperature coefficient of electrical resistivity observed in this and certain other titanium and zirconium alloys. The diffusion controlled, isothermal formation of omega resulted in a metastable equilibrium involving an enriched beta phase. The $\omega-\beta$ transus line was identified for this metastable equilibrium. (auth)

12637 (GEAP-4089(Vol.I)(Paper 11)) THE EFFECT OF HEAT TREATMENT ON THE MECHANICAL PROPERTIES OF THE ZIRCONIUM-2½% NIOBIUM ALLOY. J. Winton and R. Murgatroyd (United Kingdom Atomic Energy Authority. [Industrial Group. Culcheth Labs., Culcheth, Lancs, England]). 30p.

A wide range of heat-treatment variables was investigated to determine their effects on the mechanical properties of Zr-2.5% Nb alloy. On the basis of this work a specific heat treatment schedule is recommended. The effects of quenching variables on tensile properties, the effect of aging, impact properties, fatigue, and creep were studied. It was found that it is essential to quench faster than a critical rate in order to obtain consistent properties and a good aging response. It was also found that an aging temperature of 500°C gives a sufficiently rapid increase in strength together with good ductility for aging times of about 5 hr. (M.C.G.)

12638 (GEAP-4089(Vol.II)(Paper 12)) THE ROLE OF DEFORMATION TWINNING IN THE PLASTIC DEFORMATION OF ZIRCONIUM. R. E. Reed-Hill (Florida. Univ., Gainesville). 28p.

Twinning in plastic deformation of zirconium was investigated. All specimens were deformed in tension on an Instron machine. The material was annealed Wah Chang arc-melted songe zirconium. Twinning modes in zirconium are described. Test results are shown in pictures and graphs. (M.C.G.)

12639 (GEAP-4089(Vol.II)(Paper 14)) TENSILE PROPERTIES OF ZIRCALOY WITH ORIENTED HYDRIDES. R. P. Marshall and M. R. Louthan, Jr. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). 17p.

Room temperature tensile tests were conducted to determine the effect of hydrogen content and hydride orientation on the tensile properties of Zircaloy-4 tubing. It was found that hydride platelets oriented nearly perpendicular to the deforming tensile stress caused large reductions in strength and ductility, whereas the platelets oriented nearly parallel to deforming stress had little effect on the tensile properties. All specimens containing more than 50 ppm hydrogen as "normal" (perpendicular) hydrides exhibited no macroscopic ductility, irrespective of the total hydrogen content. (auth)

12640 (GEAP-4089(Vol.II)(Paper 20)) NOTE ON THE DEFECT STRUCTURE OF ZrO_2 AND HfO_2. P. Kofstad and D. J. Ruzicka (Sentralinstitutt for Industriell Forskning, Blindern, Norway). 18p.

The defect structure of ZrO_2 and HfO_2 was studied through measurements of electrical conductivity as a function of oxygen pressure. The electrical conductivity exhibits a complex oxygen pressure dependence, and to explain the results it was proposed that these oxides are ionic conductors, and that a "coupled" transport of oxygen vacancies and interstitials is faster than an independent transport of these defects. Thermogravimetric measurements on ZrO_2 suggested that the nonstoichiometry of this oxide is more than a factor of ten smaller than that observed by Aronson. (auth)

12641 (GEAP-4089(Vol.II)(Paper 21)) PRELIMINARY EXPERIMENTS ON THE USE OF AC POLAROGRAPHY TECHNIQUES IN THE DETERMINATION OF HYDROGEN TRANSPORT MECHANISMS IN ZIRCONIUM ALLOY OXIDE FILMS. E. G. Brush (General Electric Co. Atomic Power Equipment Dept., [Pleasanton, Calif.]). 30p.

Conduction measurements, under a specific experimental adaption of ac polarographic techniques, made on zirconium and on Zircaloy-2 oxide films did not yield information regarding the nature of the hydrogen transport mechanism through the film that occurs during exposure to high temperature water. The measurements did suggest electronic leakage analogs, which tend to support tendril type leakage paths and associated rectification "valves", at least in the anodically grown films. (auth)

12642 (GEAP-4089(Vol.II)(Paper 22)) HYDROGEN OVERVOLTAGE AT ZIRCONIUM INTERMETALLICS. J. S. Armijo (General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.). 17p.

Hydrogen overvoltage η, at zirconium and zirconium intermetallics was measured in aqueous 1M H_2SO_4. Measurements were made at 25°C over the current density range 10^{-5} to 1 amp cm^{-2}. The Tafel equations for these measurements as expressed in kinetic form are: for Zr, $i = 7.04 \times 10^{-7} \times \exp(2.303\eta/0.136)$; for Zr_2Cu, $i = 1.86 \times 10^{-6} \times \exp(2.303\eta/0.153)$; for Zr_2Ni, $i = 4.79 \times 10^{-7} \times \exp(2.303\eta/0.123)$; for ZrV_2, $i = 1.42 \times 10^{-6} \times \exp(2.303\eta/0.119)$; and, for Zr-90 wt % Nb, $i = 5.44 \times 10^{-7} \times \exp(2.303\eta/0.096)$. A correlation of overvoltage with metal hydrogen bond strength is reported and a model for hydrogen pickup in unoxidized metals is discussed. (auth)

12643 (HW-76303(p.2.1-35)) CERAMICS RESEARCH. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Various phases of ceramics research are considered. Phase studies of eutectic PuO_2–43 mole % MgO are presented for 2100°C. An attempt to synthesize a solid solution of UO and PuO is reported. The compatibility of β–Pu_2O_3 with Ta, Mo, W, Nb, and V at 1650°C in a helium atmosphere was studied. Dual column installation for electron microscopy of plutonium ceramics is discussed. Fission-gas release from irradiated arc-cast PuC is reported after discharge from the ETR. Weight loss from heating a PuN–50 vol % W cermet in a vacuum for 4 hr at 1000 to 1500°C is reported. The purification of PuO_2 by heating in air to remove halogens is discussed. The fabrication of standard-sample PuO_2 spheres by gas-jet grinding is reported. The particle sizes of air-oxidation-produced PuO_2 powders were studied, cermets of PuC were fabricated by impaction in Ta, Mo, and W, and thermal reactions in UO_2–W cermets were studied by electron micrography. The vaporization of UO_2 from UO_2–50 wt % W was studied. Thermal conductivity measurements were performed on polycrystalline UO_2 as part of a 4-yr follow-up program of annealing studies. Radiation damage in and optical properties of UO_2 and the infrared absorption spectrum of ThO_2 and its relation to that of UO_2 were studied. Thermal diffusivity measurements were performed on UO_2, and other high-temperature concepts are being developed. (R.E.U.)

12644 (HW-79810) STRESS-RUPTURE TESTS OF HAYNES 25 ALLOY AT HIGH TEMPERATURES. K. R. Wheeler, D. H. Nyman, and R. W. Barker (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 27, 1963. Contract AT(45-1)-1350. 4p.

Two stress-rupture curves at 2026 and 2100°F were obtained in helium for buttonhead specimens made from bar stock of Haynes 25. The results are compared with published Haynes Satellite data. Extensometer measurements gave elongations of 6 to 8% for some of the tests. (D.L.C.)

12645 (HW-79846) MICROFRACTOGRAPHY OF ALPHA PLUTONIUM—REPLICA TECHNIQUES. G. E. Miller, T. K. Bierlein, and B. Mastel (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 1963. Contract AT(45-1)-1350. 13p.

Electron microfractography has been utilized to characterize the fracture modes of deformation of unalloyed alpha plutonium over the temperature range –196 to 100°C. It has been found that the fracture mode at –196°C is entirely by intercrystalline separation. At the higher temperatures the fracture mode is primarily by transgranular cleavage with some evidence of ductile shear. (auth)

12646 (MCW-1482(p.5-9)) LIQUIDUS TEMPERATURES IN THE CaF_2–LiF–UF_4 AND CaF_2–LiF–UF_3 SYSTEMS. R. D. Piper and J. W. Starbuck (Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Mo.).

Liquidus temperatures were determined in the CaF_2-rich corner of the CaF_2–LiF–UF_4 and CaF_2–LiF–UF_3 systems as a guide for operating a uranium-producing electrolytic cell with a frozen crust sidewall. (auth)

12647 (MCW-1482) DETERMINATION OF THE PHASE DIAGRAM FOR THE SYSTEM U–Al–Fe WITH AN ELEC-

TRON MICROPROBE. L. A. Fergason and N. F. Neumann (Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Mo.).

The 1200°F isothermal section of the U–UAl_2–UFe_2 phase diagram was investigated with an electron microprobe. A phase field of alpha U–UAl_2(Fe)–U_6Fe with 3.6 at.% Fe in solution is described. There was no detectable solubility of aluminum in U_6Fe. A solubility of 8 at.% Fe in UAl_2 was determined in the phase field UAl_2–$U(Fe,Al)_2$–U_6Fe. (auth)

12648 (MCW-1482(p.27-35)) ANALYSIS OF URANIUM ALLOYS WITH THE ELECTRON MICROPROBE. L. A. Fergason and D. L. Parker (Mallinckrodt Chemical Works. Uranium Div., Weldon Spring, Mo.).

The scanning electron microprobe was used to determine uranium in UAl_2, UAl_4, UC, U_6Fe, UP, U_3Si, and U_3Si_2. Successful corrections for self-absorption and atomic number effects were made following the method of Poole and Thomas. (auth)

12649 (NAA-SR-Memo-8598) ALLOY CHARACTERIZATION STUDIES OF ALUMINUM POWDER METALLURGY (APM) PRODUCTS UTILIZING THE ELECTRON MICROSCOPE. E. G. Szymborski (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). June 18, 1963. Contract AT-11-1-GEN-8. 21p.

The strength characteristics of APM products are dependent upon fabrication history and the size and distribution of the aluminum oxide particles. Evaluation of APM products produced by the Swiss (AIAG's SAP-930), and the U. S. (Alcoa's XAP-005) was accomplished by electron microscopy techniques utilizing replicas and thin sections. Comparisons between the two materials were made with respect to size and distribution of the oxide particles, and size and number of iron-rich inclusions. The oxide particles ranged from 0.025 to 1.6 microns. The larger particles appeared to be agglomerates of many smaller particles. The spacing between particles ranged from 0.1 to 0.3 microns. These values were equal for SAP-930 and XAP-005. SAP-930 revealed a greater number of oxide particle agglomerates, in addition to more and larger aluminum-rich areas than XAP-005. Comparisons of the inclusions showed a greater number and larger inclusion sizes in SAP-930 than in XAP-005. Based on preliminary data, the XAP-005 (Alcoa) appears superior to the SAP-930 (AIAG) with respect to homogeneity of particle size and distribution. More work is recommended to characterize the two alloys throughout various stages of fabrication, and to correlate microstructure with mechanical properties. (auth)

12650 (NAA-SR-Memo-9334) THERMAL CONDUCTIVITY OF 3ZI. R. E. Taylor (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 17, 1963. Contract [AT(11-1)-Gen-8]. 14p.

The thermal conductivity values of 3ZI were obtained by two different methods. One of these methods is based on the experimental measurement of the thermal diffusivity and the other method utilizes an empirical relationship between the thermal and electrical conductivities. The results agreed with each other within 15%. The best values for the thermal conductivity obtained in the temperature range from room temperature to 1100°F are believed accurate within 5%. (auth)

12651 (NCSC-2663-15) URANIUM INTERSTITIAL PHASES. Quarterly Report. John V. Hamme and Robert F. Stoops (North Carolina State Coll., Raleigh). Dec. 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(40-1)-2663. 17p. (EURAEC-958)

The existence of a complete solid-solution series between UC and UN was confirmed by chemical analyses and x-ray diffraction analyses. When the compositions of the solid solution were plotted versus the lattice parameters, the deviation from Vegard's law was very small. Based upon x-ray diffraction analyses, a complete range of solid solution exists between $U(C_{0.75}O_{0.25})$ and UN. Under the conditions of the experiments the ratio of the carbon to oxygen did not change with increasing UN solution in so far as could be determined by the x-ray diffraction technique. Hot-pressed specimens with densities as high as 91% of theoretical were made at temperatures below 1400°C and pressures of 3000 psi. (auth)

12652 (NP-13593) STUDY OF DUCTILE COATINGS FOR THE OXIDATION PROTECTION OF COLUMBIUM & MOLYBDENUM ALLOYS. Third BiMonthly Progress Report, November 1–December 31, 1963. (Metals and Controls Inc., Attleboro, Mass.). Contract NOw63-0707-c. 15p.

Oxidation tests were performed on platinum and platinum–10% rhodium alloy. The effect of air flow rate on oxidation rate was studied at 1200 and 1400°C. The rate of oxidation of platinum at 1525°C was determined in an air flow of 24 ipm. Binary composites of platinum on niobium and molybdenum were prepared and tested. The methods used in sample preparation did not provide sufficient edge protection and several new methods are being considered. Methods were selected for preparation of coating-diffusion barrier-base metal composites. An attempt was made to form an alumina diffusion barrier on FS-85 alloy through the reaction of aluminum foil with oxide on the surface of the alloy. The film formed was not satisfactory. (auth)

12653 (ORNL-3557) MECHANICAL PROPERTIES OF X8001 AND 6061 ALUMINUM ALLOYS AND ALUMINUM-BASE FUEL DISPERSION AT ELEVATED TEMPERATURES. W. R. Martin and J. R. Weir (Oak Ridge National Lab., Tenn.). Feb. 1964. Contract W-7405-eng-26. 33p.

The mechanical properties of two aluminum alloys and a fuel dispersion have been investigated for the purpose of selecting a cladding material and supplying data for design evaluation of the Advanced Test Reactor fuel plates. The properties of the X8001, 6061, and the U_3O_8–Al dispersion were investigated. The creep properties of these materials in uniaxial tension were measured in the temperature range of 400 to 600°F for maximum strains of 1.0% and times of 450 hr. The tensile properties were measured from 70 to 600°F. The 6061-0 is stronger in short-time tension and creep than the X8001-0 material. The tensile strength of X8001 can be increased by cold working. Recovery of the cold-worked X8001 and 6061 alloys was investigated and compared with the kinetics of the overaging of the 6061 alloy in the T6 condition. The fuel dispersion is stronger in creep than the X8001-0 matrix material. The tensile strength of the fuel dispersion is approximately twice that of X8001-0. (auth)

12654 (PG-Report-502) ANALYTICAL METHOD FOR THE DETERMINATION OF THE SPECIFIC SURFACE AREA OF PLUTONIUM OXIDE POWDER (B.E.T. METHOD). (United Kingdom Atomic Energy Authority. Production Group, Windscale, Sellafield, England). 1963. 14p.

The outgassed plutonium oxide sample is exposed to nitrogen gas at the temperature of liquid nitrogen until equilibrium is established between unadsorbed and adsorbed gas. By varying the system volume several values are obtained for the equilibrium pressures. From

the pressure-volume relationships a B.E.T. plot is made from which the Specific Surface Area is calculated. The precision of the method is three times the standard deviation and equals about 10% (as determined on 6 samples at the 50 m^2/g level). The method is applicable as written to plutonium oxide powder samples of specific surface area not less than 5 m^2/g. (auth)

12655 (SC-DC-64-303) BERYLLIUM STUDY PROGRAM. Quarterly Progress Report, September 23–December 31, 1963. J. L. Blumenthal and Myrrl Santy (Thompson Ramo Wooldridge Inc. TRW Space Technology Labs., Redondo Beach, Calif.). Jan. 7, 1964. For Sandia Corp., Albuquerque, N. Mex. Contracts [AT(29-1)-789] and 82-6211. 54p.

The constant volume reaction kinetics system for studying beryllium was designed, fabricated, and calibrated. Preliminary checkout experiments with molten aluminum were completed. A study of the kinetics of the reaction of beryllium with pure oxygen at 1000 to 1500°C was made. The effect of temperature, pressure, and surface coverage on the reaction kinetics was investigated. The experiments showed that above the beryllium melting point (1280°C) oxidation was rapid, non-protective, and proportional to the square root of the oxygen pressure. The reaction rate increased exponentially with increasing temperature and the activation energy was about 70,000 cal/mole. Preliminary microscopic studies indicated that a portion of the beryllium oxide reaction product formed from the oxidation of beryllium above its melting point was in the airborne particle size range (<10 microns). A preliminary design of the plasma-flame tank system was completed. (auth)

12656 (TID-20234) DENDRITE GROWTH IN SUPERCOOLED METALS. Annual Report. Wylie J. Childs (Rensselaer Polytechnic Inst., Troy, N. Y.). Feb. 1964. Contract AT(30-1)-3004. 7p.

The multiple thermocouple technique for measuring the velocity of dendrite growth in supercooled bismuth and bismuth–cadmium alloys is described and evaluated. (N.W.R.)

12657 STRUCTURE RELATIONS BETWEEN URANIUM-CONTAINING LAVES PHASES UNDER A RELATION OF A NEW PHASE $U(Fe,Al)_2$. Siegfried Steeb, Guenter Petzow, and Raghav Tank (Max-Planck-Institut für Metallforschung, Stuttgart). Acta Cryst., 17: 90-5 (Feb. 10, 1964). (In German)

The mutual solubility of UAl_2 and UFe_2 amounts to 19 mole % at 1000°C and is accompanied by a change of lattice constants according to the larger radius of Al. A ternary compound $U(Fe,Al)_2$ (C14 type) was found in the quasi-binary system UAl_2–UFe_2, ranging from 33 to 59 mole % UAl_2. It may be explained in terms of Laves phases. The relative solubility of the structure types C14, C15, and C36 was studied as a function of electron concentration and some new points of view regarding the stacking sequence are given. (auth)

12658 TERNARY URANIUM(V) OXIDES. W. Ruedorff, S. Kemmler, and H. Leutner (Universität, Tübingen, Ger.). Angew. Chem., 74: 429-30(Dec. 1962). (In German)

A cubical phase occurs in the Li_2O–U_2O_5 system as $Li_2O \cdot 2\,U_2O_5$. It has a CaF_2 superstructure with empty anion positions. At lower Li_2O concentrations the cubical phase becomes hexagonal. Its lattice constants ($a = 6.81_5$ Å, $c = 4.13_8$ Å) are almost the same as the U_2O_5 modification taking place at 400 to 600°C. This may be due to a smaller amount of Li_2O-stabilized U_2O_5. At very low Li_2O concentration (1 Li_2O: 15–20 U_2O_5) the hexagonal lines split in the direction of the lines of the rhombic α–U_2O_5 modification and the lines of $UO_{2.25}$ appear in the x-ray pattern. MgO–U_2O_5 and $CdO \cdot U_2O_5$ crystallize in a fluoride lattice with statistical distribution of cations $(Me^{2+}_{0.33}U^{5+}_{0.67})O_2$. The Cd compound reacts with additional CdO to form a rhomboid phase whose upper boundary resembles 2 $CdO \cdot U_2O_5$. In the $PbO \cdot U_2O_5$ system there are 2 PbO-rich phases: a cubical phase with a homogeneity range of ~1.6 $PbO \cdot U_2O_5$ to 2.25 $PbO \cdot U_2O_5$, and a rhomboid phase of ~2.5 $PbO \cdot U_2O_5$. (TCO)

12659 STUDIES ON A ZONE OF THE TERNARY SYSTEM BaO–SrO–Fe_2O_3. I. EQUILIBRIUM DIAGRAM OF THE ISOTHERMIC SECTION AT 1100°C OF THE ZONE COMPRISED OF HEMATITE, BARIUM FERRITE $2BaO \cdot Fe_2O_3$, AND THE ANALOGOUS STRONTIUM FERRITE $2SrO \cdot Fe_2O_3$. Pietro Batti (Università, Trieste, Italy). Ann. Chim. (Rome), 52: 1227-47(Dec. 1962). (In Italian)

Forty-eight compositions within the system Fe_2O_3, $2BaO \cdot Fe_2O_3$, $2SrO \cdot Fe_2O_3$ were examined by a combination of microscopy and roentgenography. The existence of the following previously noted binary compounds was confirmed: $2BaO \cdot Fe_2O_3$, $BaO \cdot Fe_2O_3$, $BaO \cdot 6Fe_2O_3$, $SrO \cdot 6Fe_2O_3$, $7SrO \cdot 5Fe_2O_3$, $2SrO \cdot Fe_2O_3$. A ternary compound, $BaO \cdot SrO \cdot 2Fe_2O_3$, was also found, as well as the following solid solutions: complete solution of $BaO \cdot 6Fe_2O_3$ and $SrO \cdot 6Fe_2O_3$; partial solution of $BaO \cdot SrO \cdot 2Fe_2O_3$ in $BaO \cdot Fe_2O_3$, becoming saturated at 60% ternary compound; partial solution of $BaO \cdot Fe_2O_3$ in $BaO \cdot SrO \cdot 2Fe_2O_3$, becoming saturated at about 5% binary compound; partial solution of $2SrO \cdot Fe_2O_3$ in $2BaO \cdot Fe_2O_3$, extending to about 6% $2SrO \cdot Fe_2O_3$; and a partial solution of $2BaO \cdot Fe_2O_3$ in $2SrO \cdot Fe_2O_3$, from 26 to 100% $2BaO \cdot Fe_2O_3$. The isothermal section at 1100°C is presented graphically; it includes 8 pseudo-binary equilibrium regions and 5 ternary regions; 18 photomicrographs are given. For the system $2BaO \cdot Fe_2O_3$–$2SrO \cdot Fe_2O_3$, the variation of lattice distances corresponding to hkl = 220, 222, and 400 is plotted as a function of composition. Five intermediate compositions were examined from 30 to 80% $2SrO \cdot Fe_2O_3$ and indicate a smooth decrease in these distances in the whole region. (BBB)

12660 MICROSCOPIC STUDY OF THE SYSTEM SrO–TiO_2. Antonio Cocco and Franco Massazza (Università, Trieste, Italy). Ann. Chim. (Rome), 53: 883-93(July 1963). (In Italian)

The system SrO–TiO_2 above 1200°C was examined with the aid of reflection microscopy; nine photomicrographs are given. Four compounds are formed: $SrO \cdot TiO_2$, stable throughout the temperature range, m.p. ~1900°C (congruent); $3SrO \cdot 2TiO_2$, stable below 1580°C, above this decomposing to $SrO \cdot TiO_2$ and alpha $2SrO \cdot TiO_2$; $2SrO \cdot TiO_2$, in two allotropic forms, alpha and beta (point of inversion about 1525°C), m.p. 1860°C (incongruent); and $3SrO \cdot TiO_2$, stable from 1560 to 1760°C, decomposing to alpha $2SrO \cdot TiO_2$ and SrO above and below this range. A solid solution of SrO in $3SrO \cdot TiO_2$ is formed and corresponds approximately to $4SrO \cdot 3TiO_2$; probably another solid solution of $3SrO \cdot 2TiO_2$ in $SrO \cdot TiO_2$ exists. Two eutectics are formed: one between $SrO \cdot TiO_2$ and TiO_2, m.p. 1440°C, 78 mole % TiO_2; one between $2SrO \cdot TiO_2$ and SrO, m.p. 1800°C, 20 mole % TiO_2. A probable phase diagram is presented. Aqueous 1% HCl plus 1% HF attacks beta $2SrO \cdot TiO_2$ to a considerable extent within 10 min, but does not attack $3SrO \cdot 2TiO_2$; 2% HF in water attacks neither $SrO \cdot TiO_2$ nor $3SrO \cdot 2TiO_2$, but attacks mixtures approaching the composition $4SrO \cdot 3TiO_2$. A bibliography of earlier work in the system $SrO \cdot TiO_2$ is given. (BBB)

12661 THE PHYSICAL METALLURGY OF ZIRCONIUM. D. L. Douglass (General Electric Co., Pleasanton, Calif.). At. Energy Rev., 1: No. 4, 71-237(1963).

A critical review and analysis of the physical metallurgy of zirconium was made for the period 1953–1963 in order to bring the subject up to date. Topics covered include: crystallography; physical properties; deformation and textures; recovery, recrystallization, and grain growth; theory of alloying; phase equilibria; phase transformations and heat treatment; mechanical properties; diffusion; and irradiation effects. 302 references are included. (auth)

12662 STUDY OF THE FIRST STAGE OF THE NATURAL FRITTING OF URANIUM POWDER IN THE β AND α PHASE, USING ISOTHERMAL DILATOMETRY. Bernard Pinteau and Georges Cizeron (Ecole des Mines, Paris). Compt. Rend., 257: 3903-5(Dec. 16, 1963). (In French)

The kinetic study in the α and β phases of the isothermal shrinking shown by agglomerates of uranium powder, initially compressed at room temperature, permitted a determination of the nature of the mechanisms operating at the initiation of the fritting in these two temperature regions. In addition, the effect of the grain enlargement accompanying the $\alpha \rightarrow \beta$ transformation is shown by a slowing down of the shrinkage kinetics in the β phase. (tr-auth)

12663 REACTIONS OF NICKEL WITH URANIUM CARBIDES. Francois Anselin, Daniel Calais, Guy Dean, and Annick Van Graeynest (CEN, Fontenay-aux-Roses, France). Compt. Rend., 257: 3916-18(Dec. 16, 1963). (In French)

During a study on the kinetics of the fritting of uranium carbides containing small quantities of Ni, the reactions of UC and U_2C_3 with Ni were studied. It was shown that the ternary compound UC_2Ni is formed in all cases. The presence of diverse inclusions in the fritted carbides and their relative proportions were thus explained. Iron and cobalt, which play a role analogous to Ni in the fritting of carbides, give compounds of the same type, UC_2Fe and UC_2Co. (tr-auth)

12664 THE EFFECT OF PRE-DEFORMATION AT 20°C ON THE PLASTIC DEFORMATION OF POLYCRYSTALLINE URANIUM AT –196°C. Andre Lemogne, Jean Morin, and Paul Lacombe (Ecole Nationale des Mines, Paris). Compt. Rend., 258: 910-13(Jan. 20, 1964). (In French)

For elongations at 20°C > about 2%, the constraint of rupture at –196°C and that of plastic flow at 20°C are in a constant ratio. (tr-auth)

12665 THE USE OF WATER IN NUCLEAR REACTORS. P. Ageron, H. Dudebout, R. Semeria, and J. Villeneuve. Eau, L, 50: 249-55(May 1963). (In French)

The merits of water as a coolant, moderator or shielding are discussed. The moderating properties of light and heavy water are compared with those of Be and graphite, and its thermodynamic and heat transfer properties are described. Corrosion, boiling, and neutron activation are also considered. (D.C.W.)

12666 THE USE AND TREATMENT OF WATER AT THE CHINON NUCLEAR POWER PLANT. E. Robert and J. Hustache. Eau, L, 50: 259-67(May 1963). (In French)

The properties, treatments, and uses of water at the center are described, together with the treatment and circulation systems. (D.C.W.)

12667 STATION FOR TREATING WATER FROM THE RHONE FOR COOLING THE G1 PILE AND FOR VARIOUS ASSOCIATED USES. P. Joly and J. Hugot. Eau, L, 50: 279-83(May 1963). (In French)

Water treatment is described, as well as the installation itself. Operation of the plant is also described. (D.C.W.)

12668 THERMAL DIFFUSIVITY IN TUNGSTEN AT TEMPERATURES BETWEEN 1600 AND 2960°C. O. A. Kraev and A. A. Stel'makh (Inst. of Thermophysics, Siberian Branch, Academy of Sciences, USSR). High Temp., 1: 5-8(July-Aug. 1963).

A method for measuring thermal diffusivity in metals at high temperatures is presented. The method is based on the propagation of temperature waves in a plane sample heated by electron bombardment. The experimental setup and the validity of the method is described. Results are given for the thermal diffusivity in tungsten at temperatures between 1600 and 2960°C. (auth)

12669 SPECTRAL COEFFICIENTS OF TANTALUM, MOLYBDENUM, AND NIOBIUM RADIATION. B. A. Khrustalev, I. P. Kolchenogova, and A. M. Rakov (Krzhizhanovskii Energetics Inst., USSR). High Temp., 1: 13-18(July-Aug. 1963).

Radiation coefficients of Ta, Mo, and Nb corresponding to the effective wavelength of a pyrometer were determined. Emissivities were determined in a wide range of temperatures for different surface conditions of the materials. The Nb specimens, whose emissivities were determined, were in the form of seamless thin-wall tubes. Heating in an atmosphere of argon with a trace of oxygen resulted in surface oxidation and an increase in emissivity. Nb was tested mainly in vacuum. When an initially uncalcined specimen was heated in vacuum its emissivity increased. It was concluded that the accuracy of the results was properly estimated and the results obtained are reliable. (P.C.H.)

12670 EXPERIMENTAL DETERMINATION OF THE INTEGRAL EMISSIVITY OF METALS AND ALLOYS AT HIGH TEMPERATURES. V. A. Petrov, V. Ya. Chekhovskoi, and A. E. Sheinblin (Scientific Research Inst. of High Temperatures, Academy of Sciences, USSR). High Temp., 1: 19-23(July-Aug. 1963).

A description is given of an experimental apparatus for determining the integral emissivity of metals and alloys at high temperatures up to the melting point of the materials. The investigated specimen in the form of a thin-walled tube is heated with electric current. Blackbody conditions are created in the tube for measurements of the true temperature. The apparatus was used to determine the emissivity of molybdenum. (auth)

12671 VARIATION OF THE ELECTRICAL RESISTANCE OF LIQUID METALS WITH THE SPECIFIC VOLUME. A. N. Solov'ev. High Temp., 1: 37-40(July-Aug. 1963).

The dependence of the electrical resistance on the specific volume was analyzed. A simple relationship was found and extrapolated to high temperatures. It is shown that the recalculated atomic electrical resistances of liquid alkali metals are identical. The density and electrical resistance of francium was calculated. (auth)

12672 THERMAL CONDUCTIVITY OF TITANIUM CARBIDE, ZIRCONIUM CARBIDE, AND TITANIUM NITRIDE AT HIGH TEMPERATURES. R. E. Taylor and J. Morreale (Atomics International, Canoga Park, Calif.). J. Am. Ceram. Soc., 47: 69-73(Feb. 21, 1964).

The thermal conductivity of titanium carbide, zirconium carbide, and titanium nitride was measured by a variety of techniques in the temperature range 200 to 2000°C. The titanium nitride results are a factor of four

higher than previously published values at 1000°C and show a positive temperature coefficient for the thermal conductivity rather than the negative coefficient previously reported. Contemporary theory fails to explain the temperature dependency of the phonon and/or electron contribution to the heat conduction in the refractory interstitial compounds. (P.C.H.)

12673 RARE-EARTH NIOBATES AND TANTALATES OF DEFECT FLUORITE- AND WEBERITE-TYPE STRUCTURES. H. P. Rooksby and E. A. D. White (General Electric Co. Ltd., Wembley, Eng.). J. Am. Ceram. Soc., 47: 94-6(Feb. 21, 1964).

By firing 3/1 mixtures of rare earth oxide ($A_2^{3+}O_3$) and niobia or tantala ($B_2^{5+}O_5$) at high temperatures, compounds of composition $A_3^{3+}B^{5+}O_7$ may be prepared. The crystal structures of such compounds were examined and two related types were found. These are identified as a cubic defect fluorite or pyrochlore-like type and one analogous to orthorhombic weberite. Lanthanum and neodymium oxides form compounds with the orthorhombic structure, whereas with samarium, gadolinium, dysprosium, yttrium, and scandium oxides the compounds are cubic. For a given rare earth the lattice parameters of compounds prepared with either niobia or tantala are substantially the same. The division between the weberite-type and defect fluorite-type structures appears to depend primarily on the radius of the rare-earth cation, the cations of largest radii producing the deformed orthorhombic structure. (auth)

12674 GRAPHITE DEFECTS OBSERVED BY ELECTRON MICROSCOPY. G. Bonfiglioli and A. Mojoni (Instituto Elettrotecnico Nazionale Galileo Ferrais, Turin). J. Appl. Phys., 35: 683-5(Mar. 1964).

Structural defects of natural graphite are characterized by Newton-ring-like electron microscopic contrast. Pictures are given, evidencing their aspect, their peculiar distribution (often corresponding to linear alignment), and their behavior at high temperatures. A discussion is presented concerning related theoretical and experimental results of other authors and in particular the relationship of these defects to radiation damage. (auth)

12675 FORMATION OF "ABSORPTION CONTRAST EFFECT IN bcc METALS." B. Hudson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Appl. Phys., 35: 724-5(Mar. 1964).

The contours visible from a symmetrical "spider-like" contrast effect in many bcc metal foils examined by electron microscopy, are interpreted in terms of the intersection of extinction contours in a spherically curved foil. It is concluded that "spiders" appear in any crystal foil with a symmetrical orientation that has spherical- or saddle-type curvature. (R.E.U.)

12676 PROPERTIES OF MOLYBDENUM–PERMALLOY FILMS. K. Y. Ahn and W. R. Beam (Rensselaer Polytechnic Inst., Troy, N. Y.). J. Appl. Phys., 35: 832-3(Mar. 1964).

Ternary alloy films were produced by variable-ratio sequential and simultaneous two-source evaporation under conditions comparable to those of technical Permalloy film evaporation. Intrinsic film properties measured at Mo concentrations up to 6 to 8% indicated reductions of M, H_c, H_k, and dispersion. At high Mo concentrations, oblique incidence produced strong anisotropies. Crystallite dimensions were substantially less than in normal Permalloy films, and increased resistance to annealing was observed. (auth)

12677 MAGNETIC PROPERTIES OF CUBE-TEXTURED 6-81.3 Mo–PERMALLOY. Yuzo Odani (Nippon Telegraph and Telephone Public Corp., Tokyo). J. Appl. Phys., 35: 865-6(Mar. 1964).

A study was made of the magnetic properties of Mo-Permalloy sheets containing 5.3 to 6.8% Mo and 79.5 to 82.5% Ni that were cold-rolled and annealed to obtain a nearly perfect (100) [001] texture. Square hysteresis loops were obtained only in compositions of about 81.3% Ni quenched from temperatures greater than 500°C, in hydrogen. Magnetic properties of spiral cores made of insulated 0.05-mm thick 6–81.3 Mo–Permalloy tapes were as follows: (a) When annealed at 1150°C to prevent secondary recrystallization, a square loop with μ_m = 1200 000, $\mu_0 \leq 10\,000$, Hc = 0.004 Oe, and Mr/Ms = 0.92 was obtained. (b) When annealed at 1170°C, secondary recrystallization occurred; the μ_0 of the core was increased to 160,000. (auth)

12678 INFLUENCE OF THE THERMAL AND MECHANICAL HISTORY ON THE SQUARENESS CHARACTERISTICS OF 4-79 MOLYBDENUM PERMALLOY. G. Y. Chin (Bell Telephone Labs., Inc., Murray Hill, N. J.), L. L. Vanskike, and H. L. Andrews. J. Appl. Phys., 35: 867-9(Mar, 1964).

A correlation was obtained between crystallographic texture and the squareness characteristics of 4-79 molybdenum Permalloy wire and tape. When cold drawn (99% RA) 2.18-mil-diam Permalloy wire was annealed at 800°C for 0 to 7.8 sec, 60 cps Br/Bs values (measured along the wire axis) dropped from 0.95 to 0.70. Further drawing of the annealed wires to 1.3 mil resulted in an increase of Br/Bs, relative to the 2.18-mil wire, for the short-anneal (0.31 and 0.65 sec) samples and a decrease for the long-anneal (1.3 and 7.8 sec) samples. The trend was reversed when the 1.3-mil wires were roll-flattened to tapes such that the direction of flow was perpendicular to the wire axis. X-ray studies indicated a strong ⟨111⟩ fiber texture in the cold-drawn wire and a ⟨100⟩ + ⟨111⟩ double texture after annealing, the ratio of ⟨100⟩ to ⟨111⟩ intensity increasing with annealing time. The tapes contained (100) [001] and (1$\bar{1}$0) [111]6° texture components, the intensities of which were related, respectively, to those of ⟨100⟩ and ⟨111⟩ components in the original wire. It appears that drawing of a ⟨111⟩ wire leads to increased squareness, in contrast to the ⟨100⟩ case; the reverse behavior, however, was exhibited in tapes roll-flattened from wires of these two textures. These results are discussed in terms of a "slip-induced directional order" theory. (auth)

12679 MAGNETIZATION OF GADOLINIUM NEAR ITS CURIE TEMPERATURE. F. J. Darnell and W. H. Cloud (E. I. du Pont de Nemours and Co., Wilmington, Del.). J. Appl. Phys., 35: 935-6(Mar. 1964).

Magnetization measurements on single crystals of gadolinium yield a Curie temperature of 290 ± 1°K, determined by a plot of M^2 vs H/M. Measurements of magnetization vs applied field extrapolated to zero field show appreciable magnetic order above this temperature. X ray lattice parameter measurements on the same crystals allow estimation of magnetization in zero field and confirm the presence of magnetic order up to ~305°. The zero field moment at 290°, M(T = 290°)/M(T = 0°), is estimated from lattice expansion to be 0.3, compared to a value of 0.2 obtained from the extrapolated magnetization measurements. (auth)

12680 MAGNETIC SUSCEPTIBILITIES OF Mo–Tc BINARY ALLOYS. D. J. Lam, D. O. Van Ostenburg, and

D. W. Pracht (Argonne National Lab., Ill.). J. Appl. Phys., 35: 976-7(Mar. 1964).

Magnetic susceptibilities of binary Mo–Tc alloys were measured in the temperature range from 300°K to the superconducting transition temperature. The room-temperature magnetic susceptibility increases from pure Mo (82.5×10^{-6} emu/g-atom) to a small maximum (96.5×10^{-6} emu/g-atom) at the equiatomic composition. Further additions of Tc produce a decrease which reaches a minimum at 70 at.% Tc ($\chi = 87.3 \times 10^{-6}$ emu/g-atom). Beyond this composition there is another increase to the value of 120.8×10^{-6} emu/g-atom for the pure Tc. No Curie or Curie-Weiss type of temperature dependence of the susceptibility was observed in all the alloys in the temperature range investigated. The results are discussed in relation to the band theory of metals and some generalizations about the d-band form of the three transition metal series having the same electron concentrations are made. (auth)

12681 RARE EARTH-CONDUCTION ELECTRON INTERACTION IN 4d AND 5d LAVES PHASES COMPOUNDS. D. Shaltiel, J. H. Wernick, and V. Jaccarino (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 35: 978-9(Mar. 1964).

A systematic investigation was made of the sign and magnitude of the g shifts of Gd impurities in the AB_2 intermetallic Laves phase compounds. Gd was partially substituted in the A site for the elements Sc, Y, La, Th, U, and Zr. The B sites are occupied by elements of the 4d and 5d group whose positions in the periodic table are such as to correspond to an almost filled d band (e.g., Ru, Os, and Rh). Negative Gd g shifts, Δg, up to 7% were observed; the highest was that found in $LaRu_2$. It was found that the closer a B element was to having a filled d shell the larger was the g value. It appears, in keeping with our previous EPR measurements on Gd in Rh–Pd, Pd–Ag alloys and in Cu_5Ca intermetallic compounds, that without exception the g shifts are negative when the d band is nearly filled in the host alloy and that the g value has a minimum as a function of the atomic position in the host d band metal. In very fine powders of the hard superconductors $(Ce_{0.99}Gd_{0.01})Ru_2$ and $(Th_{0.99}Gd_{0.01})Ru_2$ no change in the Gd g shift was observed in going from the normal to the superconductor state. For the superconductor $(La_{0.11}Ce_{0.89})Ru_2$ the La Knight shift was also observed not to change in going from well above to well below the superconducting transition temperature. In both experiments $Ho \ll$ the upper critical field. (auth)

12682 NEW FERROMAGNETIC 5:2 COMPOUNDS IN THE RARE-EARTH–PALLADIUM SYSTEMS. A. E. Berkowitz, F. Holtzberg, and S. Methfessel (IBM, Yorktown Heights, N. Y.). J. Appl. Phys., 35: 1030-1(Mar. 1964).

Magnetic properties of new compounds in the rare earth–palladium system were studied. Gd_5Pd_2 is ferromagnetic below 335°K. The isostructural $Tb_{5.10}Pb_{1.90}$, $Dy_{5.07}Pd_{1.93}$, and $Ho_{5.04}Pd_{1.96}$ have paramagnetic metamagnetic transitions at 62, 41, and 27°K, respectively, and become ferromagnetic at lower temperatures with extremely high hysteresis. Energy products $(B \times H)_{max} = 20$ to 26×10^6 GOe at 4.2°K were observed. (auth)

12683 MAGNETIC PROPERTIES OF Fe_3MnTm AND SOME RELATED INTERMETALLIC COMPOUNDS. H. J. Williams, R. C. Sherwood, J. H. Wernick, and E. A. Nesbitt (Bell Telephone Labs., Murray Hill, N. J.). J. Appl. Phys., 35: 1032-3(Mar. 1964).

The magnetic properties of intermetallic compounds of stoichiometry Fe_3MnR, where R is Y, Tm, Er, Dy, or Ho, were measured in fields up to 14 kOe at temperatures ranging from 1.4 to 300°K and in fields up to 80 kOe at 4.2°K. The moments of the Mn and R atoms are in opposition to those of the Fe atoms so that a compensation point is observed for Fe_3MnTm. When Fe_3MnTm is cooled in a weak field from 300°K through its compensation point at 60 to 4.2°K, the magnetization reverses and a field of 25 kOe is required to reduce it to zero. (auth)

12684 SPIRAL STRUCTURE AND MOMENTS IN Gd–Dy ALLOYS. R. M. Bozorth and J. C. Suits (IBM, Yorktown Heights, N. Y.). J. Appl. Phys., 35: 1039-40(Mar. 1964).

Magnetic moment and electrical resistivity measurements of the Curie (T_C) and Néel (T_N) points of Gd–Dy alloys show that the region of spiral structure between T_C and T_N narrows as Gd is added to Dy and disappears at about 50 at.% Gd. Apparently no spiral structure exists in Gd or Gd-rich alloys. The magnetic moments of Dy-rich alloys show the saturation expected when the magnetization is confined to the hexagonal plane ($Jg\pi/4$), but the moments gradually approach the theoretical Jg as the Gd content increases toward 100%. The spin disorder resistivities are not linear in $(g-1)^2J(J+1)$; this suggests a variation in the electronic structure of these alloys. (auth)

12685 CHANGES IN MAGNETIZATION OF SINGLE-CRYSTAL DYSPROSIUM, ERBIUM, AND HOLMIUM IN HIGH MAGNETIC FIELDS. R. B. Flippen (E. I. du Pont de Nemours and Co., Wilmington, Del.). J. Appl. Phys., 35: 1047-8(Mar. 1964).

Measurements are reported on the behavior of magnetization with field of single-crystal dysprosium, erbium, and holmium in pulsed magnetic fields up to 165 kOe. These elements go progressively on decreasing temperature from a paramagnetic to antiferromagnetic to ferromagnetic state. Sufficiently high external fields applied along spin axes in single-crystal samples can cause spin realignment by overcoming the internal exchange and anisotropy fields. The strengths of the internal fields can be determined in this manner. Measurements with an external field H applied in the basal plane of Dy and of Ho, and with H parallel to the c axis in Er, confirm previous static field measurements of H_c for the AF/F transition. No change in spin alignment is seen in Dy with H parallel to c up to 165 kOe. In Ho below 80°K fields near 100 kOe produce strong changes in magnetization with H parallel to the c axis. Below 20°K fields up to 17 kOe in the basal plane in Er produce a sharp change in magnetization indicative of spin realignment. The magnetization of Er with H parallel to a is measured at 4.2°K in static fields up to 56 kOe. The magnetization increases sharply between 15 and 20 kOe, reaching 50 emu/g at 20 kOe. Little change is found above 40 kOe where M is 120 emu/g. These results are discussed with regard to the internal fields in Dy, Ho, and Er. (auth)

12686 METAMAGNETISM OF SOME RARE-EARTH COPPER COMPOUNDS WITH $CeCu_2$ STRUCTURE. R. C. Sherwood, H. J. Williams, and J. H. Wernick (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 35: 1049-50(Mar. 1964).

Magnetic moments of the series of rare-earth copper (RCu_2) intermetallic compounds were measured at temperatures from 1.4 to 300°K. These compounds have an orthorhombic crystal structure and are isostructural with $CeCu_2$. The susceptibility at high temperatures of most of the compounds followed the Curie-Weiss law giving effective moments close to those of the trivalent rare-earth

ions. Eu and Yb appeared to be divalent. At low fields antiferromagnetic behavior was indicated in some of these compounds by peaks in the curves of moment vs temperature, and by a lack of remanence. Metamagnetic behavior was observed when measurements were made at 4.2°K and with fields up to 80,000 Oe. The moment of $TbCu_2$ increased abruptly at a critical field, and at 80,000 Oe, although not yet saturated, had a moment of 6.2 Bohr magnetons. The moments of $EuCu_2$ and $GdCu_2$ increased gradually, and at 80,000 Oe reached moments of 5.7 and 6.0 Bohr magnetons, respectively. These results indicate a relatively weak antiferromagnetic exchange interaction in these compounds. (auth)

12687 ELECTRONIC SPECIFIC HEAT ASSOCIATED WITH LOCALIZED STATES IN ACTINIDE METALS. W. R. Scott, V. Jaccarino, J. H. Wernick, and J. P. Maita (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 35: 1092-3(Mar. 1964).

Motivated by the observations that the substitution of U for Th in the intermetallic compounds $ThAl_2$ results in the formation of localized magnetic moments at the uranium sites, measurements were made of the low-temperature specific heat of a range of compounds, $Th_{1-x}U_xAl_2$, in the temperature range 1.7 to 20°K. It was observed that the value of γ, the electronic contribution, increases with the addition of U; which increases are associated with the formation of localized 5f-like states on the U atoms and close to the Fermi energy. The change in density of states per U atom ranges from 140 states ev^{-1} per U atom on the addition of 0.5 at.% U to 80 states ev^{-1} per U atom on the addition of 18 at.% U. That these states contribute to the specific heat indicates that they form close to the Fermi energy, a condition, within the framework of current theories, favorable to their being magnetized. (auth)

12688 ROOM-TEMPERATURE RESISTIVITY OF Mo–Nb AND Mo–Re ALLOYS CONTAINING ONE PERCENT IRON. Myriam P. Sarachik (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 35: 1094-5 (Mar. 1964).

The room temperature resistivity was measured for a series of molybdenum–niobium and molybdenum–rhenium alloys, with and without 1% iron as solute. A maximum in the scattering due to the iron is found near the alloy composition for which a localized moment first appears. The results are interpreted in the light of current theories of localized moments. (auth)

12689 EVAPORATION COEFFICIENT OF GRAPHITE. Richard P. Burns, Andrew J. Jason, and Mark G. Ingram (Univ. of Chicago). J. Chem. Phys., 40: 1161-2(Feb. 15, 1964).

The evaporation coefficient of graphite was determined by means of a mass spectrometer for individual gaseous species, as a function of crystal orientation. The measurement was made by determining the ratio of the rate of evaporation from the outer surface of a pyrolytic graphite, isothermal (±5°K), Knudsen cell to that evaporating through the orifice of the same cell. The absence of temperature dependence of the evaporation coefficients and the thermal nature of the C_1 and C_2 molecules places severe limitations on the possible explanations for the low evaporation coefficients. The data indicate that the ratio of evaporation coefficients of the two crystal surfaces of graphite is different from unity and that it has a value of approximately $\alpha_1^c/\alpha_1^a = 1/3$. (P.C.H.)

12690 ALLOYS OF THORIUM WITH CERTAIN TRANSITION METALS. II. THE SYSTEMS THORIUM–OSMIUM, THORIUM–IRIDIUM AND THORIUM–PLATINUM. J. R. Thomson (Imperial Coll. of Science and Tech., London). J. Less-Common Metals, 6: 3-10(Jan. 1964).

The thorium–osmium, thorium–iridium, and thorium–platinum binary systems were studied over the whole range of compositions in the temperature range 1000–1500°C mainly by metallographic and x-ray methods. Intermetallic compounds occur in each system and solid solubility in thorium at 1000°C is very low. (auth)

12691 SOME OBSERVATIONS OF THE DEFORMATION MECHANISMS OF NIOBIUM. A. Fourdeux and A. Wronski (Union Carbide European Research Associates, Brussels). J. Less-Common Metals, 6: 11-20(Jan. 1964).

Tensile properties of flash-annealed and conventionally recrystallized niobium were studied at room temperature and at 77°K. Twinning at 77°K at stresses lower than the predicted value of the Peierls–Nabarro force proved that it is not this that causes the large temperature dependence on the yield stress. Electron microscopic examination of foils loaded at room temperature to <3 kg/mm^2 showed that edge dislocations are mobile before the apparent proportional limit of the flash-annealed niobium, ~3.5 kg/mm^2, is reached. At this temperature and 1% min^{-1} strain rate the material was characterized by an absence of an upper yield point, high work hardening rate and high U.T.S./yield-stress ratio. At 77°K even specimens taken from the same foil did not have reproducible properties due to twinning starting at or continuing to (500 kg/mm^2 was recorded) various stress values. (auth)

12692 AN APPRAISAL OF POSSIBLE SCAVENGER ELEMENTS FOR CHROMIUM AND CHROMIUM ALLOYS. N. E. Ryan (Aeronautical Research Labs., Fisherman's Bend, Melbourne). J. Less-Common Metals, 6: 21-35 (Jan. 1964).

An assessment was made of the properties of selected scavenger additions either to remove or to stabilize the interstitial impurities that may be present in chromium. The investigation combined a consideration of the available thermodynamic data with a metallographic examination of cast alloys. Ce, La, Hf, Th, Ti, U, Y, and Zr readily reacted with nitrogen in chromium during melting and casting. Nb and Ta formed complex nitrides with Cr during heat treatment of the cast alloy. Ce, La, Ti, Y, and Zr were found to be strong scavengers for oxygen in Cr. Monocarbides of Nb, Ta, Th, Ti, U, and Zr were produced in Cr–C alloys. Effective scavenging of interstitial impurities in commercial grades of Cr was achieved with stoichiometric additions of Ce, Ti, Y, and Zr. (auth)

12693 THE ELECTRONIC STATE OF CERIUM IN ZIRCONIUM–CERIUM ALLOYS. I. R. Harris and G. V. Raynor (Univ. of Birmingham, Eng.). J. Less-Common Metals, 6: 70-80(Jan. 1964).

In order to compare the lattice spacing relationships in the thorium–cerium and zirconium–cerium systems, lattice spacings were measured for a series of zirconium-rich zirconium–cerium alloys annealed to equilibrium at 655, 680, 730, 780, 830, and 850°C, and quenched. Both the a- and c-spacings of zirconium are expanded by cerium. The axial ratio c/a is increased from 1.5927 for zirconium to 1.5934 at 1 at.% cerium but is constant at higher cerium contents. The solid solubility, as deduced from lattice spacings of duplex alloys, falls from 6.0 at.% cerium at 850°C to 0.8 at.% at 655°C. Except for the value at 655°C, the solubility conforms to the relationship $\log S \propto I/T^0A$. The effective atomic diameter of cerium in solid solution in zirconium, obtained by extrapolation to 100% Ce of the atomic volume/composition curve for the zirconium-rich alloys, is 3.238 kX, as compared with 3.642 kX for γ

cerium. In discussion the effective atomic diameter for cerium is compared with that observed in thorium-rich thorium–cerium alloys; it was concluded that in both cases cerium contracts by assuming a higher valency state than that corresponding to γ cerium, in order to avoid the strain that would result if no electronic rearrangement took place. Since the magnitude of this strain energy would be greater in zirconium as solvent than in thorium, the resulting cerium contraction is more marked, and corresponds to the assumption of a valency of 4. (auth)

12694 THE EQUILIBRIUM DIAGRAM OF THE SYSTEM MOLYBDENUM–PALLADIUM. E. Anderson (Oxford Univ.). J. Less-Common Metals, 6: 81-4(Jan. 1964).

Studies were made on the Pd-rich end of the Mo–Pd equilibrium diagram. The existence of an intermediate close-packed hexagonal ε phase was confirmed, and it exists over a narrow range of composition at about 52 at.% Pd. The Pd-rich terminal solid solution showed a maximum freezing point at about 61 at.% Pd, and also gave rise to a lattice spacing/composition curve with a minimum lattice spacing at about 10 at.% Mo. The results also confirmed the tendency previously noted that in alloys of elements from Groups VIA with those of VIIIC, the solubility in the element of Group VIIIC is usually the greater. (P.C.H.)

12695 THE CARBIDES OF URANIUM. B. R. T. Frost (U.K.A.E.A. Research Group, Harwell, Berks, Eng.). J. Nucl. Mater., 10: 265-300(Dec. 1963).

A review is presented on the crystallography and properties of the three carbides of U, with particular emphasis on the monocarbide. Fabrication methods are briefly discussed. The properties of most importance to fuel element performance, compatibility and irradiation behavior, are included. (P.C.H.)

12696 STUDY OF URANIUM AND PLUTONIUM NITRIDES AND THEIR SOLID SOLUTIONS. F. Anselin (CEN, Fontenay aux Roses, France). J. Nucl. Mater., 10: 301-20 (Dec. 1963). (In French)

The development of uranium and plutonium nitrides or their solid solutions as a possible fuel element for fast breeder-reactors, is conditioned by possibilities of production of those compounds on a large scale and by the evaluation of their general properties. A low temperature preparation method of uranium nitrides is described. Under pressure nitrogen reacts with massive-metallic uranium samples when superficially hydrided. Higher nitrides so produced have a mean composition range $UN_{1.75}$–$UN_{1.77}$. Uranium mononitride, UN, is obtained by dissociation of $UN_{1.77}$ under vacuum at 800°C or higher temperatures. With plutonium for which no higher nitride exists, mononitride is directly prepared by metal nitration. Under the same conditions no solid solutions (UPu)N can be prepared by nitration of U/Pu alloys; a mixture of $(UN)_{1.77}$ and (UPu)N is obtained. Densities of 87% of theoretical density are obtained by natural sintering of UN compacts. Sintering improvement and grain growth are observed when an uranium liquid phase is present. Low metallic additions do not improve the sintering behavior, but bodies with 90% of theoretical density can be obtained with small addition of oxydes such as UO_2, ZrO_2. After diffusion in solid state of UN–PuN mixture, the solid solution obtained can be sintered to 90% of theoretical density. The dissociation of UN and PuN above 1650°C and the strong volatilization of PuN at high temperature are characteristic features of those compounds. The lattice parameter of (UPu)N solid solutions prepared at 900°C increases linearly with PuN content. For solid solutions annealed at higher temperature the lattice parameter follows a linear variation with a different slope. In conclusion general properties of nitrides and carbides as possible fuel elements are compared. (auth)

12697 METALLOGRAPHIC STUDY OF THE TRANSFORMATION OF γ PHASE INTO (α + γ′) PHASES IN A U–1.6 wt % Mo ALLOY. G. Oestberg, M. Moeller, and B. Schoenning-Christiansson (Aktiebolaget Atomenergi, Stockholm). J. Nucl. Mater., 10: 329-38(Dec. 1963).

The isothermal transformation of γ in U–1.6 wt % Mo between 500 and 640°C was studied by means of ordinary light and electron microscopy and X-ray diffraction. The sequence of phases appearing at the isothermal levels was γ, (α + γ) at 600 and 640°C; γ, (α + γ), (α + γ + γ′), and (α + γ′) at 550°C, (α′ + γ), (α + α′ + γ), and (α + α′ + γ′) at 525°C; (α′ + γ) and (α + α′ + γ) at 500°C. The α phase had the form of Widmanstätten plates and between these lie the γ and later the γ′. The Mo content of the first formed α phase was almost the same as that of the parent 1.6% Mo γ phase and decreased later to approach the metastable equilibrium with γ, and finally γ′. The Mo content of the γ phase rose correspondingly and attained a value approximately the same as for γ′ at 525 and 550°C, 15–17 and 16–18%, respectively. The TTT diagram for the transformation of γ conformed to the normal type for this kind of processes with C-curves for the beginning and the end of the formation of α and γ′. (auth)

12698 THE MECHANICAL PROPERTIES OF PLUTONIUM–ALUMINUM AND PLUTONIUM–CERIUM ALLOYS. D. C. Miller and J. S. White (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). J. Nucl. Mater., 10: 339-45(Dec. 1963).

An investigation was made of the mechanical properties of Pu–Al and Pu–Ce alloys in the range 0 at % solute to the upper limit of the delta stabilized field. The compositional dependence of the UTS, flow stress, elongation, reduction in area, Young's Modulus, density, and hardness was determined for each series of alloys. From a consideration of the data new positions for the (α + δ)/δ phase boundary were proposed for the two alloy systems. The main factors influencing the solution hardening of delta-stabilized plutonium alloys are also discussed in relation to the results obtained. (auth)

12699 DIRECTIONAL DIFFUSION IN MAGNESIUM ALLOYS. J. E. Harris and R. B. Jones (Berkeley Nuclear Labs., Berkeley, Gloucestershire, Eng.). J. Nucl. Mater., 10: 360-2(Dec. 1963).

Tests were made to determine if directional diffusion creep is an important deformation mode in Mg alloys. It was concluded that the preferred orientation of the precipitate-free zones should be attributed to directional diffusion and that this process is the dominant deformation mode. Studies were also made on the possibility of directional diffusion creep processes occurring in magnesium components during their service life in a thermal reactor. Deformation of a Mg–0.8 wt % Al–0.005 wt % Be alloy was considered. The results indicated that a diffusion creep mechanism may operate under typical reactor service conditions. It was concluded that neglect of the possibility of diffusion creep occurring at low stresses can lead to serious under-estimates of the deformation rates likely to occur in practice. (P.C.H.)

12700 THE DENSITY OF SOLUTIONS OF NICKEL IN LIQUID BISMUTH AT 800°C. L. E. Richards and S. W. Strauss (Naval Research Lab., Washington, D. C.). J. Nucl. Mater., 10: 363-4(Dec. 1963).

The density of Bi–Ni solutions was investigated. A plot

of atomic fraction Ni versus the difference in density between solution and solvent indicates that: the densities of the solutions are greater than that of liquid Bi at the same temperature, 800°C, even though less dense Ni was added to the molten Bi; and the densities of the solutions increase with increase in Ni content over the concentration region investigated (25 at. % Ni). The continuous increase in density of the liquid metal solutions, coupled with the observation that at 25 at. % Ni the value of $\Delta\rho$ corresponds to a density of the solutions that is about 5% higher than that of liquid Bi, is taken as supporting evidence that the very small values of $\Delta\rho$ observed in the low concentration region are indeed real. (P.C.H.)

12701 THE MODULUS OF RUPTURE OF UNSINTERED URANIUM OXIDE COMPACTS. I. H. Warren and H. Shimizu (Univ. of British Columbia, Vancouver). J. Nucl. Mater., 10: 365-9(Dec. 1963).

An attempt was made to increase the green strength of hydrometallurgically prepared UO_2 by the addition of other, less hard, uranium oxides that might promote adhesion and thus eliminate the necessity of using organic binders. It was found that a major increase of modulus of rupture accompanies chemical mixing, such as peroxidation, but not mechanical mixing of peroxide dihydrates with UO_2. This suggests that more than increased adhesion via Van der Waals forces is necessary for higher strength. A decrease in modulus of rupture with the virtual disappearance of hydrate water upon heating peroxidized material to 135°C indicates that high strength was associated with the presence of either $H_2UO_5 \cdot H_2O$ (peroxide dihydrate) or $H_2UO_4 \cdot H_2O$ (trioxide dihydrate) or of both hydrates simultaneously. The correlation of the maintenance of high strength at 100°C with the retention of peroxide and loss of much trioxide dihydrate suggests that peroxide dihydrate plays a dominant role in imparting high strength to the peroxidized material. (P.C.H.)

12702 COMPATIBILITY OF URANIUM DIOXIDE AND ALUMINUM. 1. KINETIC STUDIES OF UO_2–Al REACTION IN MIXED POWDER COMPACTS. H. E. Roellig (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Kernenergie, 6: 685-91(Dec. 1963). (In German)

Reaction kinetics in the Al–UO_2 system were investigated. The reaction rates in pressed mixed powders, which contained equal parts by weight UO_2 and Al, were determined at various temperatures. Both an oxide free (exactly: oxide poor) aluminum and also a powder with 10% oxide content were used. The reaction proceeded at aluminum excess according to the equation $3UO_2 + 16Al \rightarrow 3UAl_4 + 2Al_2O_3$. The oxide-containing material reacted more slowly. From the reaction rate constants ascertained at 570, 595, and 620°C, the activation energies and temperature dependence of the reaction were determined. The reaction mechanisms and the threshold phenomena observed for the reaction are discussed. (tr-auth)

12703 INVESTIGATIONS IN THE SYSTEMS: Hf–B–C AND Zr–B–C. H. Nowotny, E. Ruby, and F. Benesovsky (Universität, Vienna). Monatsh. Chem., 92: 393-402(1961). (In German)

The ternary phase diagram for the system Hf–B–C is given. The following 2-phase equilibria exist: $Hf(C,B)_{1-x}$ (B 1)–Hf(B,C) (B 27); $Hf(C,B)_{1-x}$(B 1)–HfB_2; HfB_2–C; HfB_2–B_4C. The homogeneous region of the B 1 phase is smaller than in the corresponding N system. The maximum solubility of B in HfC is 6 at.%; the parameter then becomes a = 4.646 Å (HfC: a = 4.632 Å). In ternary mixtures the 2-phase region HfB (B 27)–Hf(C,B) (B 1) exists. The solubility of C and HfC in HfB_2 is practically nil. The monoboride (B 27) is not stable at high temperatures and the ternary region is covered by diboride and Hf(C,B) (B 1). Lattice constants are given for a large region of the system; those for cooled samples do not differ from those annealed at 1500°C, nor is there indication of a disintegration process. In the phase diagram of the system Zr–B–C, no ZrB (B 1) is indicated, in distinction to the Hf system. In the region Zr–ZrB_2–ZrC show these types in increasing quantities; cooled samples in the region ZrB–ZrC gave only these crystal types. No B-1 lattice pair, one for C-rich and the other B-rich, was found. No difference in lattice constant was found for samples cooled or annealed at 1400°C. ZrC_{1-x} dissolves little B; ZrB_{12} was not found either at 1400°C or in ternary samples. Only the following two-phase equilibria exist: ZrB_2–ZrC_{1-x}, ZrB_2–C, ZrB_2–B_4C. Mixtures of the high-melting compounds can be separated by the proper metal or metal mixed crystals; very hard alloys consisting of ZrB_2 and ZrC_{1-x} with little bound Zr may be obtained. (BBB)

12704 INVESTIGATIONS IN THE TERNARY SYSTEMS: V–Al–Si, Nb–Al–Si, Cr–Al–Si, Mo–Al–Si, AND Cr(Mo)–Al–Si. C. Brukl, H. Nowotny, and F. Benesovsky (Universität, Vienna). Monatsh. Chem., 92: 967-80(1961). (In German)

Alloys of the type Me–Al–Si (Me = V, Nb, Cr, Mo) were prepared either by cold pressing and reaction at 1200°C or by hot pressing and after-compression. In the system V–Al–Si, Si may be replaced by Al in VSi_2 up to ca $V(Si_xAl_y)_2$. Little substitution was noted in the T 1 phase; a third type of crystal was observed. The system Nb–Al–Si was completely determined, and the ternary phase diagram is given. The regions and parameters of the σ phase, T 1 and T 2 phases, the disilicide of C 40 type, and $Nb(Al,Si)_2$ (C 54) are shown. T 2 dissolves practically no Al. A T 1 powder pattern is tabulated; T 1 possesses a homogeneous region of 5 at.%, but T 2 does not. In the system Cr–Al–Si, regions of mixed phases of the types A 15, T 1, and C 40 are found. Al may replace Si in $CrSi_2$. Lattice constants for several Cr–Si–Al C 40 phases, indicating the maximal replacement of Si by Al as 25%, are given. The same information is given for the T 1 and A 15 systems; maximum replacement is 7–8% and ca 50%, respectively. In the system Mo–Al–Si (phase diagram given) a smooth transition between Mo_3Si and Mo_3Al, exchange of Si by Al in the T 1 phase, and a ternary form of C 40 structure are noted. A new ternary C 54 structure of the type $Mo(Al,Si)_2$ was observed. In the system Cr–Mo–Al–Si the smooth transition Cr_5Si_3–Mo_5Si_3 (T 1) was studied; at a ratio Al/Si = 1 $Cr_3(Al,Si)$ and $Mo_3(Al,Si)$ show a complete transition; in Cr_5Si_3–Mo_5Si_3 Si may be replaced by Al; the region $(Cr,Mo)(Al,Si)_2$ C 40 was studied extensively. Alloys of these systems provide potential carriers of nonscaling materials. (BBB)

12705 THE MIXING BEHAVIOR OF Nb_3Sn WITH Mo_3Si, Mo_3Ge, AND Nb_3Ge. H. Holleck, F. Benesovsky, and H. Nowotny (Universität, Vienna). Monatsh. Chem., 93: 996-9(1962). (In German)

The change in lattice constant with composition was examined for Mo_3Si, Mo_3Ge, and Nb_3Ge in connection with changes in the superconductivity point in these mixtures. The samples were prepared by sintering or fusing mixtures containing 20, 40, 60, and 80 mole % Nb_3Sn. For $Nb_3(Ge,Sn)$ a homogeneous series of mixtures is indicated by the change in lattice parameter from 5.29 kX.E (Nb_3Sn) to 5.17 (Nb_3Ge; extrapolated value from graph, 5.17). In the system $(Nb,Zr)_3Sn$ the bounded phase has a slightly increased

parameter, 5.32 kX.E; no homogeneous transition at high temperatures to Zr_4Sn would be expected for the Zr system from these data. The existence of the mixed phases $(Mo,Nb)_3(Si,Sn)$ and $(Mo,Nb)_3(Ge,Sn)$ follows from the smooth change of the lattice parameter in these systems; the dependence on mole % is nearly linear. The parameter for pure Mo_3Si is 4.88 kX.E; for Mo_3Ge, 4.93. The data permit the estimation of similar unstable phase parameters: Nb_3Si, 5.11; Mo_3Sn, 5.06. Si/Sn exchange is strongly favored by the simultaneous replacement of Mo by Nb. (BBB)

12706 TERNARY PHASES CONTAINING CARBON (Nb_3Al_3C AND Ta_3Al_2C). W. Jeitschko, H. Nowotny, and F. Benesovsky (Universität, Vienna). Monatsh. Chem., 94: 332-3(1963). (In German)

Examples of the metalloid-stabilized class of the type M_nMe_mX (M = transition metal, Me = metametal, X = metalloid) are reported. In these phases, such as Mo_3Al_2C, the arrangement of the metal atoms corresponds to the β-manganese type, with the 4 interstices occupied by C atoms. Lattice parameters were determined to be 7.05_1 for Nb_3Al_2C and 7.02_5 kX.E for Ta_3Al_2C; the roentgen density was calculated to be ideally 6.49 g/cm³ for the Nb phase and 11.59 g/cm³ for the Ta phase. In 5 systems of similar composition (Ti–Al–C, V–Al–C, Nb–Al–C, Ta–Al–C, and Cr–Al–C) a new ternary phase was observed and named the H-phase. Powder patterns indicate a simple hexagonal subcell for the phases with low-scattering transition metals. The composition is not completely determined, but it occurs in a homogeneous region of most of these systems. Analogous, closely related phases evidently exist in the systems Zr–Sn–C, Hf–Sn–C, V–Ge–C, and Cr–Ge–C; the crystal types in the pair Zr–Sn–C and Hf–Sn–C and in the pair V–Ge–C and Cr–Ge–C are completely isotypic in each set. (BBB)

12707 A CONTRIBUTION TO THE TERNARY SYSTEM: THORIUM–SILICON–GERMANIUM. P. Stecher, F. Benesovsky, and H. Nowotny (Metallwerk Plansee AG, Reutte, Tyrol, Austria and Universität, Vienna). Monatsh. Chem., 94: 549-64(1963). (In German)

Powdered Th (0.026% O, 0.12% C, 0.047% Fe, and 0.25% Si), Si (99.7% Si), and pure Ge were combined under cold compression followed by reaction at 1200 to 1300°C. By means of x-ray analysis and mp determinations, composition diagrams were obtained for Th–Si and Th–Ge. The distribution of the ternary phase diagram Th–Si–Ge was studied at ~1300°C. The phase most rich in Th in the Th–Ge system was Th_2Ge. This had a $CuAl_2$ structure with a = 7.414 and c = 6.081 Å. In Th_2Ge there was a Ge/Si exchange of ~60%. Th_3Si_2 and Th_3Ge_2 form a continuous mixture. ThSi dissolves almost 80 mol % of ThGe, but Ge/Si substitution of ThGe is only ~12 mol %. Although there are isotypes, there is no continuous transition between Th_3Si_5 and Th_3Ge_5. The parameters for the pseudo-hexagonal cell, Th_3Ge_5, were a = 4.065 and c = 4.202 Å. The pair, α–$ThSi_2$ and α–$ThGe_2$, exhibit a continuous transformation. Under the experimental conditions the mixed phase as well as the binary phases showed a range of homogeneity of ~5 at.% toward the Th-rich side. In the phase $Th_{0.9}Ge_2(ThGe_{2.0\pm0.4})$ a Ge/Si exchange of ~45% can take place. The results suggest the possibility of formation of phases spaced apart by voids in the area between 33 and 40 at.% Th. (BBB)

12708 THE CRYSTAL STRUCTURES OF ScHg, $ScHg_3$, YCd, YHg, AND YHg_3. E. Laube and H. Nowotny (Universität, Vienna). Monatsh. Chem., 94: 851-8(1963). (In German)

The compounds (ScHg, $ScHg_3$, YCd, YHg, and YHg_3) were prepared by heating the elements in sealed quartz ampules to ~550°C; heat was liberated in the reactions. In many samples Sc_2O_3 or Y_2O_3 could be detected; there was a concentration change in the intermetallic compound, ascribed to the reactivity of Sc and Y. The ScHg, YCd, and YHg phases all have the CsCl (B 2) structure. When the ratio of transition metal to meta metal was 3:1, free Sc was observed in the Sc–Hg mixture; in the Y–Cd and Y–Hg, free Y and Y_2O_3 were detected. Lattice parameters (body-centered) were: ScHg, 3.47_3 kX.E; YCd, 3.71_3; YHg, 3.67; evaluations of Debye-Scherrer plots are tabulated for these systems. The lattice parameters are in accord with those of previously known B2 types; it is suggested that the bonding in these systems is strongly polar. Evaluations of Debye-Scherrer plots for the samples of $ScHg_3$ and YHg_3 indicate a $MgCd_3$ structure (DO_{19}) for these. Lattice parameters are: $ScHg_3$, a = 6.35_8, c = 4.75_2, 2c/a = 1.49_5; YHg_3, a = 6.52_8, c = 4.86, 2c/a = 1.48_9. The agreement between observed and calculated data is tabulated; x = 0.833; the agreement of the parameters with those of $LaHg_3$ points to this structure as well. (BBB)

12709 TEMPERATURE DEPENDENCE OF CRITICAL SHEAR STRESS OF MOLYBDENUM SINGLE CRYSTALS. Chi-wei Lung and Tsing Ho (Inst. of Metal Research, Academia Sinica, Shenyang, China). Sci. Sinica (Peking), 13: 160-2(Jan. 1964).

Single crystals of industrial pure Mo were grown by the strain-anneal technique, annealed at 1800°C in a vacuum furnace, and polished electrolytically before testing. Results are reported from tensile tests carried out between −140° and 300°C in a mixture of liquid air and alcohol. The logarithm value of critical resolved shear stress varied linearly with the absolute temperature. (C.H.)

12710 CRYSTALLOCHEMICAL RELATIONSHIPS IN THE INTERMETALLIC COMPOUNDS OF THE RARE EARTH METALS. P. I. Kripyakevich, E. I. Gladyshevskii, O. S. Zarechnyuk, V. I. Evdokimenko, I. I. Zalutskii, and D. P. Frankevich (Moscow State Univ.). Soviet Phys.-Cryst. (English Transl.), 8: 477-80(Jan.-Feb. 1964).

Experimental studies of the structures of the intermetallic compounds of the rare earth metals are used to investigate some points relating to the crystallochemistry of these compounds (isostructural forms, morphotropy, relation between lattice constants of compounds and atomic number of the rare earth metal, and formation of ternary compounds). (auth)

12711 AN X-RAY DIFFRACTION STUDY OF SOLID SOLUTIONS OF Al, Co, Cr, Sc, IN La AND Pr ORTHOFERRITES. A. A. Katsnel'son and K. Yatskul'yak (Moscow State Univ). Soviet Phys.-Cryst. (English Transl.), 8: 481-3(Jan.-Feb. 1964).

A study was made of the changes that occurred in the orthoferrites $LaFeO_3$ and $PrFeO_3$ when Al, Co, Cr, and Sc ions were dissolved in them. Replacement of part of the Fe ions by these ions leads to changes in the lattice parameters. On replacing Fe by Al, a weakening of intensity of those lines with sum of indices odd was observed. This is explained by ordered distribution of Al in the lattice. On the x-ray patterns of a number of specimens line broadening was observed, and harmonic analysis of their profiles showed this to be due to high dispersion in the specimens. The connection between the structural changes observed and the magnetic properties is discussed. (auth)

12712 AN X-RAY DIFFRACTION INVESTIGATION OF THE MAGNETIC AND ELECTRIC PROPERTIES OF THE SYSTEM $BiFeO_3$–$LaFeO_3$. Yu. E. Roginskaya, Yu. N.

Venevtsev, S. A. Fedulov, and G. S. Zhdanov (Karpov Inst. of Physics and Chemistry, Moscow). Soviet Phys.-Cryst. (English Transl.), 8: 490-4(Jan.-Feb. 1964).

In the system under investigation the presence of a continuous series of solid solutions, existing in four modifications (rhombohedral and three pseudomonoclinic) is established. In the rhombohedral region the ferroelectric, and in the pseudomonoclinic I the antiferroelectric properties are combined with noncollinear antiferromagnetism. At the boundary of these two modifications there is an abrupt discontinuity in the spontaneous magnetization at room temperature, apparently pointing to the relation between electric and magnetic states in this system. (auth)

12713 MECHANICAL BEHAVIOR OF CRYSTALLINE SOLIDS. Proceedings of a Symposium ... at the 64th Annual Meeting of the American Ceramic Society in New York City, April 28-29, 1962. (National Bureau of Standards, Washington, D. C.). National Bureau of Standards Monograph 59. Mar. 25, 1963. 116p. $1.75(GPO).

Crystal imperfections and their effects on the mechanical behavior of ceramic materials are discussed. Plastic flow and fracture of crystalline solids, the theory of dislocations, observations of dislocations, fracture mechanisms in crystalline ceramics, strength of ceramic crystals, and the effect of microstructure on the mechanical behavior of polycrystalline ceramics are considered. Numerous references are cited. (C.E.S.)

12714 ELASTIC PROPERTIES OF CARBONS AND GRAPHITE. James Fletcher Andrew. Thesis, Buffalo, State Univ. of New York, 1963. 85p.

The dependence of the elastic constants, permanent set, and hysteresis effects of widely different C materials on both the heat-treatment temperature and the ambient temperature of measurement was experimentally determined. Four basic types of carbons were prepared in the laboratory; soft filler-soft binder, soft filler-hard binder, hard filler-soft binder and hard filler-hard binder. The room-temperature creep and the corresponding unrecoverable permanent set were found to depend logarithmically on the time of application of the bending force, thus showing the absence of viscous creep. The room-temperature permanent set in C bodies with soft filler becomes larger as the heat-treatment temperature increases, whereas bodies with hard filler show practically no dependence of permanent set on the heat-treatment temperature. Hysteresis loops are observed in both force-deflection and torque-twist measurements; the second and third loops becoming progressively more narrow. The room-temperature Young's modulus and rigidity modulus have a very similar dependence on heat-treatment temperature throughout the range 500° to 3000°C for the various carbons mentioned above. The general shape of the corresponding curves seems to be dependent mainly on the type and heat treatment of the filler: a minimum at about 2200°C is present for the soft filler bodies but absent for the hard filler bodies. Studies with a high-temperature elasticity apparatus showed that a maximum in temperature dependence of Young's modulus occurs only for rods with soft filler, whereas bodies with hard filler show a continuous decrease in modulus with increasing temperature. Measurements of the elastic modulus of soft filler-soft binder rods during the heat treatment process showed a general decrease in the elastic modulus with increasing temperature, for temperatures up to 2200°C, and the presence of maxima in the elastic modulus at a temperature somewhat below the maximum heat-treatment temperature for all variously heat treated samples. A preliminary study of hard filler-hard binder rods showed neither of the effects. (M.P.G.)

12715 SEPARATION OF GRAPHITIC LINE IN DEBYEGRAM OF THE REACTOR GRAPHITE. B. Pandić (Institut "Rudjer Boskovic," Zagreb). p.33-42 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. II." Vienna, International Atomic Energy Agency, 1963. (In French)

A method is given for the determination of crystallite dimensions L_c in reactor graphite. The method consists of the mathematical correction of the diffraction profile (002) obtained by means of a Philips diffractometer with scintillation counter. During the work CuK_β radiation is used. The convenience of using CuK_β radiation rather than that of a CuK_α doublet is discussed. All instrumental errors except that of the sample adsorption are eliminated using corresponding slits. Sample adsorption is corrected mathematically. Highly symmetrical lines of graphitic and nongraphitic phase could be analytically separated from such corrected line profiles. Experimental error in the determination of the half-height and half-width of these lines does not exceed 5%. (auth)

12716 NEW PHASE IN THE SYSTEM URANIUM-MOLYBDENUM-SILICON. M. Sikirica and Z. Ban (Institut "Rudjer Boskovic," Zagreb). p.229-33 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. II." Vienna, International Atomic Energy Agency, 1963.

During the investigation of the ternary system uranium-molybdenum-silicon, a new phase with the composition $U_4Mo_5Si_3$ was formed. Structure determination exclusively based on the powder data showed that the particular phase belongs to the hexagonal system. Space group P6/mmc or one of the sub-groups is indicated. Unit cell dimensions were found to be a = 5.370 Å, c = 8.582 Å. A comparison of calculated and observed intensities shows close resemblance to the structure of the Laves phases of the C14-type. (auth)

Radiation Effects

Refer also to abstracts 12412 and 12724.

12717 (AD-296358) RADIATION EFFECTS ON SPACECRAFT ELECTRONICS SYSTEMS, COMPONENTS AND MATERIALS. AN ANNOTATED BIBLIOGRAPHY. Helen B. McCormick, comp. (Lockheed Missiles & Space Co., Sunnyvale, Calif.). Dec. 1962. 175p. (SB-62-46)

A selective bibliography of 415 references, most in abstracted form, is presented which reflects the technical literature of Jan. 1960 to July 1962. The bibliography comprises two parts dealing respectively with systems and components, and electronic materials. Personal and corporate author indexes are included. (D.L.C.)

12718 (AE-130) DISLOCATION ARRANGEMENTS IN DEFORMED AND NEUTRON-IRRADIATED ZIRCONIUM AND ZIRCALOY-2. Ram B. Roy (Aktiebolaget Atomenergi, Stockholm). 1963. 26p.

Dislocation arrangements in deformed and neutron irradiated Zr and Zircaloy-2 were studied by thin film transmission electron microscopy. Results indicate that the prominent slip system, in both Zr and Zircaloy-2, is the $\{10\bar{1}0\}\ \frac{1}{3}\ \langle 12\bar{1}0\rangle$ type: no evidence for basal slip was observed. Attractive and repulsive dislocation interactions seem to be more important than the intersection jog reactions. Elongated loops and dipoles were seen at higher deformations and it is suspected that such loops or dipoles are formed due to interactions between dislocations lying

in parallel planes. Stacking fault ribbons lying in $\{10\bar{1}0\}$ plane were found in 15% cold rolled Zircaloy-2: a rough estimate of stacking fault energy indicates that it is ~65 ergs/cm^2. Calculations show that the equilibrium separation of partials is ~60 Å and a stress as high as 19×10^{-3} μ acting along [0001] direction is needed to separate them. It is suggested that O_2 and N_2 in addition to their solid solution hardening effect may also cause a lowering of the stacking fault energy and Suzuki hardening. (auth)

12719 (CONF-187-97) BEHAVIOR OF IRRADIATED METALLIC FUEL ELEMENTS EXPOSED TO NUCLEAR EXCURSIONS IN TREAT. J. H. Monaweck, C. E. Dickerman, and E. S. Sowa (Argonne National Lab., Ill.). [1962]. Contract [W-31-109-eng-38]. 13p.

From American Nuclear Society Meeting, New York, Nov. 1963.

In order to evaluate the reactivity effects of fuel meltdown, the behavior of previously irradiated EBR II U–5% fissium and Fermi A U–10% Mo fuel pins under transient nuclear heating was studied. The clad fuel pins were first irradiated in MTR, the cladding was removed, and the irradiated pins were encapsulated again and subjected to TREAT excursions. The results confirm out-of-pile predictions of the short-time swelling upon meltdown and indicate that the amount of reactivity available upon meltdown of a fast reactor is limited considerably by the expansion. Since EBR II already has a negative sodium void coefficient of reactivity, the expansion would tend to shut down the reactor. (D.L.C.)

12720 (D2-90037-9) NATURAL SPACE RADIATION EFFECTS TO SENSITIVE SPACE SYSTEM COMPONENTS AND MATERIALS. VOL. 9. DEGRADATION TO PHOTOGRAPHIC FILM RESEARCH. R. R. Brown (Boeing Co., Seattle). Sept. 20, 1963. 45p. (N63-20172)

Degradation of photographic films is assessed to analyze space radiation damage to various sensitive systems and components and to predict operational life-times. Resolution problems of image quality and contrast for earth scanning are considered independent of radiation sensitivity, and the background fog density introduced on the film by ionizing radiation is then assessed. Although the various films considered have different thresholds for radiation sensitivity, the thresholds are directly related to their relative film speeds. Since the difficulties in developing radiation-resistant films that also retain high photographic sensitivity appear insurmountable at the present time, the immediate problem is reduced to the design of adequate shielding. The thicknesses of aluminum shielding required for protection of films of various radiation sensitivities are tabulated. Another shielding consideration stems from the generation of photo-electrons by the bremsstrahlung x rays produced in the shielding materials by the primary radiation. Since photographic film is especially sensitive to photoelectrons, a low-z material such as black polyethylene can be placed between the film and the shield. The possibility of erasing some radiation fogging occurring in orbit before exposure to light by storing the film in a carefully controlled humidity and temperature environment is also noted. (auth)

12721 (D2-90241) BOEING RADIATION EFFECTS LABORATORY. Hugh Nutley (Boeing Co., Seattle). Dec. 31, 1962. 27p. (AD-414033)

A model of the radiation effects laboratory was built to help visualize operational problems and equipment placement. A photograph of the model provides a perspective of the external features of the building. A tower houses one of the major accelerators, a Dynamitron. The second major radiation source is an electron linear accelerator. This machine is placed in the opposite end of the building from the Dynamitron. A view is given of the model with the roof and overhead shielding removed, showing certain major features of the laboratory. Because of possible settling of the building foundation over a period of years the accelerator and test areas are separated by a specially designed corridor from the control room and support laboratory areas. The laboratory building has an area of approximately 17,000 sq ft and will cost approximately $800,000. The accelerator selection and the building design were made on the basis of existing requirements for nuclear weapon and space radiation effects testing. However, the machine and building specifications were written so that many other applications could be served. A discussion is presented of the major features of the laboratory and examples given of some of the work to be accomplished. (auth)

12722 (EURAEC-542) THE EFFECT OF RADIATION ON THE DUCTILE-BRITTLE TRANSITION IN PRESSURE VESSEL STEELS. Final Report. Quarterly Report No. 8, October 1–December 14, 1962. E. Anderson, W. Bollmann, D. King, M. Malone, and J. Spreadborough (Battelle Memorial Inst. International Div., Geneva). Jan. 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 041-60-12-RDS. 19p.

In addition to outlining general progress, recent work in electron microscopy is described: a method for electromachining thin strips from 3 mm tensile rods provides good specimens, and an apparatus for the automatic electropolishing of microscope samples is working reliably. Preliminary observations by replica and transmission electron microscopy are reported for samples which have been tensile tested and examined metallographically. (auth)

12723 (GEAP-4089(Vol.II)(Paper 17)) THE CORROSION OF ZIRCALOY-2 FUEL ELEMENT CLADDING IN A BOILING WATER REACTOR ENVIRONMENT. R. C. Nelson (General Electric Co. Vallecitos Atomic Lab., [Pleasanton, Calif.]). 21p.

The metallographic technique for corrosion studies of irradiated fuel elements and some corrosion characteristics of Zircaloy-2 cladding in a boiling water reactor are described. A mounting method involving vacuum impregnation of the specimen with epoxy resin containing 0.1 μ alumina powder was developed to preserve the edge of thin surface films during grinding and polishing for subsequent metallographic examination. By this method corrosion films less than 1 μ in thickness were preserved for examination and measurement. Visual examination of pre-transition oxide films revealed them to be thin, continuous films of extremely uniform thickness, while post-transition films were highly irregular in thickness and shape. Data indicated that the corrosion is accelerated in a reactor environment. (M.C.G.)

12724 (HW-76303(p.4.1-43)) FUELS TESTING AND ANALYSIS. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Various phases of ceramic fuels testing and analysis are considered. Irradiation effects on PRTR fuel elements, with both failures and satisfactory performances, are discussed. The effects of autoclaving the fuel elements are also discussed. Factors affecting fission-gas release from UO_2–PuO_2 elements are considered. Irradiation performances of MgO–PuO_2, ZrO_2–PuO_2, and ThO_2–PuO_2 are reported. Microstructure studies in UO_2 fuels during irradiation are being made. A device for transport of test

elements from the MTR-VH-4 facility is evaluated. MTR testing of EBWR UO_2-PuO_2 elements is discussed, autoradiographic examinations were performed. The long-term irradiation testing of capsules of $W-UO_2$, W–UN, $Mo-UO_2$, and Mo–UN is reported; compatibility data were obtained. The chemical and mechanical stabilities of $W-UO_2$ were investigated in short-term irradiations. The irradiation of a UO_2 high heat flux fuel rod to a surface flux of 655 watts/cm^2 and the accompanying effects are reported. (R.E.U.)

12725 (HW-SA-3127) THE IRRADIATION PERFORMANCE OF $MgO-PuO_2$ NUCLEAR FUEL. M. D. Freshley and D. F. Carroll (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 11, 1963. Contract AT(45-1)-1350. 15p. (CONF-187-53)

From American Nuclear Society Meeting, New York, Nov. 1963.

Satisfactory irradiation performance of magnesia-base plutonia fuels operating under a variety of conditions was demonstrated. The reaction between MgO and water may limit its application in water cooled environments. Microstructural features different from those common to many irradiated ceramic fuels were observed in irradiated, sintered $MgO-PuO_2$ fuels. Radial migration of PuO_2 and fission products occurred in specimens which operated at high heat ratings. In the small columnar grain regions, however, the distribution of PuO_2 was not altered even though extensive recrystallization occurred. The fraction of fission gas released is more dependent upon power generation and fuel temperature than upon composition. Post-irradiation x-ray diffraction patterns showed no line broadening or changes in lattice parameter of MgO and PuO_2 with the exception of a localized region high in PuO_2 and fission products from which low intensity reflections were obtained. (auth)

12726 (NASA-TN-D-2098) SOLAR CELL RADIATION DAMAGE STUDIES WITH 1-Mev ELECTRONS AND 4.6-Mev PROTONS. William R. Cherry and Luther W. Slifer (National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.). Feb. 1964. 24p.

The degradation of several types of solar cells irradiated with 1 Mev electrons in stages up to $10^{16}/cm^2$ was measured under standard tungsten illumination and also under air-mass-one sunlight illumination. The degradation of similar cells irradiated with 4.6 Mev protons in stages up to $3 \times 10^{11}/cm^2$ was measured under tungsten illumination. The solar cell types included P/N cells, N/P cells with various base resistivities from less than 1 ohm-cm to 25 ohm-cm, and drift field N/P cells. The results showed that the N/P cells are conclusively more resistant to either type of radiation than the P/N cells and that, within the ranges of the experiments the N/P cells with higher base resistivity are more radiation resistant than those with lower base resistivity. The latter result is most pronounced with the electron-irradiated cells. The results also gave positive indication that the radiation resistance of solar cells is enhanced by the drift field construction. (auth)

12727 (PA-TR-3045) PRELIMINARY REPORT ON NUCLEAR RADIATION EFFECTS ON PIEZOELECTRICS. Robert Kesselman (Picatinny Arsenal. Feltman Research Labs., Dover, N. J.). Jan. 1963. 15p.

A summary is given of the preliminary data obtained on nuclear effects on lead zirconium titanate and barium titanate crystals. These results represent preliminary information on a statistically small number of samples, but certain trends seem evident (e.g., capacitance and charge release decrease under radiation). (auth)

12728 (RAI-308) THE USE OF RADIATION-INDUCED PLASTIC MEMORY TO DEVELOP NEW SPACE ERECTABLE STRUCTURES. Final Report. George Odian and Bruce S. Bernstein (Radiation Applications Inc., Long Island City, N. Y.). Apr. 15, 1963. Contract NASr-78. 130p. (N63-18164)

The elastic memory phenomenon in irradiated (crosslinked) polyethylene was studied for possible application to self-erecting space structures. In principle, the memory effect should allow the preparation of compactly folded crosslinked polymer shapes and structures which can be erected in space by the application of heat from the sun. The results of these studies show that the deformation conditions have no effect on the degree of restoration (memory). However, the restoration conditions are of major importance in controlling the degree of restoration of deformed polyethylene. Complete restoration (99+%) was found to require heating the polyethylene to transparency (135°C for high density, ca. 0.95–0.96, and 105°C for low density, ca. 0.91–0.92). The parameters that control the degree of restoration, the restoring forces that are involved, and the requirements for reducing the restoration temperatures are outlined. Methods of applying the memory effect to self-erecting structures are suggested for future research. (D.L.C.)

12729 (REIC-ACCESS-71) MONTHLY ACCESSION LIST [ON RADIATION EFFECTS DATA]. Abstracts No. 21404 to 21455. (Battelle Memorial Inst. Radiation Effects Information Center, Columbus, Ohio). Feb. 10, 1964. Includes MONTHLY ACCESSION LIST COORDINATE INDEX. Accession Lists from October 1, 1963 to January 31, 1964. Contract AF33(615)-1124. 32p. (AD-429407)

Abstracts are presented of 52 articles which were accessioned and extracted for the REIC Technical Information File during the period Jan. 1 to 31, 1964. The abstracts are arranged according to metallic materials, ceramic materials, organic materials, polymeric materials, inorganic materials, electronic materials and components, space environment and effects, experimental devices and techniques, and miscellaneous. (D.L.C.)

12730 (TRG-Report-611) SOME RDL STUDIES ON IRRADIATION EFFECTS. Contributions Prepared by Staff of the Metal Fuels Group, RDL, Windscale, for the Institute of Metals Discussion on "Metallographic and Physical Techniques for Studying Irradiation Effects," Held in London on March 26, 1963. D. Shaw, ed. (United Kingdom Atomic Energy Authority. Reactor Group, Windscale, Cumb., England). June 11, 1963. 38p.

Six papers are given on various studies of radiation effects on uranium and other nuclear materials. Only one paper was presented at the conference. Separate abstracts were prepared for all six papers. (D.L.C.)

For abstracts of individual papers see: 12731, 12732, 12733, 12734, 12735, and 12736.

12731 (TRG-Report-611(p.1-3)) ELECTRON METALLOGRAPHIC AND PHYSICAL TECHNIQUES AT TRG LABORATORIES, WINDSCALE. E. D. Hyam (United Kingdom Atomic Energy Authority. Reactor Group, Windscale, Cumb., England).

Some experimental methods which were used to study irradiated materials at Windscale are described. The methods include fractographic studies of fission gas bubbles in irradiated U and Be; production of thin foils from bulk material by electrolytic jet-machining, cellulose-acetate replica method, ultramicrotome, and composite electrode

probe; and diffusion studies making use of the activity of the solutes. (D.L.C.)

12732 (TRG-Report-611(p.4-5)) URANIUM METALLOGRAPHY AT TRG LABORATORIES, WINDSCALE. M. D. Jepson (United Kingdom Atomic Energy Authority. Reactor Group, Windscale, Cumb., England).

A brief description is given of some modified metallographic techniques which are used for the post-irradiation examination of power reactor fuel elements. The techniques include grinding, polishing, and attack-polishing. An example of the results obtained is given which shows that the structure at the surface of a uranium bar is completely destroyed by irradiation, while the structure inside the bar is unaffected. (D.L.C.)

12733 (TRG-Report-611(p.6-7)) THERMAL EXPANSION MEASUREMENTS ON IRRADIATED URANIUM. E. F. Ibrahim (United Kingdom Atomic Energy Authority. Reactor Group, Windscale, Cumb., England).

Thermal expansion coefficient measurements were made on specimens cut from the ends of U bars irradiated in the coldest reactor positions (~250°C center metal temperature). The measurements were made remotely with a modified differential dilatometer. A relationship was found between the expansion coefficient and the irradiation growth. A plot of the maximum end change measured after irradiation to 0.01 to 0.15% burnup and the end growth predicted from thermal expansion coefficients shows a definite correlation between measured and calculated values, indicating that texture and irradiation growth are responsible for the changes. (D.L.C.)

12734 (TRG-Report-611(p.8)) THERMAL CONDUCTIVITY MEASUREMENTS AT 60°C ON IRRADIATED URANIUM. A. Garlick (United Kingdom Atomic Energy Authority. Reactor Group, Windscale, Cumb., England).

Post-irradiation measurements of thermal conductivity were made on sections cut from fuel rods irradiated to various burnups in Calder. The measurements were made at 60°C using a longitudinal heat flow apparatus. The results showed that the thermal conductivity decreased rapidly at first up to ~400 Mwd/te and then more slowly at a rate of less than 1% per 1000 Mwd/te. The magnitude of the initial decrease was dependent on irradiation temperature, varying from 5% for U irradiated in the hotter channels (300 to 520°C) to 14% for U irradiated in cooler channels (200 to 300°C). (D.L.C.)

12735 (TRG-Report-611(p.9-10)) MECHANICAL TESTING OF IRRADIATED URANIUM. A. Stuttard (United Kingdom Atomic Energy Authority. Reactor Group, Windscale, Cumb., England).

Mechanical tests of irradiated and unirradiated full-length Calder fuel rods were made using the standard cast iron transverse bend test. Load-deflection curves were derived for rods irradiated at 230 and 400°C. Cross breaking strength was found to decrease rapidly at first and then decrease slowly for burnups >1000 Mwd/te. Deflection at rupture and nonelastic deflection were also determined. From the results, it is concluded that U bars irradiated to 3000 Mwd/te have sufficient strength for removal from the reactor and subsequent processing. A possible explanation is offered for the rapid loss of ductility during irradiation. Annealing effects are discussed. (D.L.C.)

12736 (TRG-Report-611(p.11)) THE PREPARATION OF TENSILE SPECIMENS FROM THE WALLS OF MAGNOX CANS FROM IRRADIATED CALDER FUEL ELEMENTS. D. Shaw (United Kingdom Atomic Energy Authority. Reactor Group, Windscale, Cumb., England).

Since no information was available on the effects of fission fragment bombardment of the inner wall of the can by uranium, tensile and creep specimens were prepared from the Magnox AL80 can walls of irradiated fuel elements. Stress-rupture tests were conducted on these specimens at 350°C. Elongations to fracture were found to decrease from 80–90% for irradiated can to 20–40% at 3000 Mwd/te, after which no further decrease occurs. (D.L.C.)

12737 (VDIT-85) RADIATION EFFECTS ON PLASTICS, ELASTOMERS, LUBRICANTS, ETC., AND SOME NATURAL ORGANIC MATERIALS. A Literature Survey. Anders Nystroem and Madeleine Seleborg (Aktiebolaget Atomenergi, Stockholm). Dec. 1963. 42p.

A bibliography of 154 references in abstracted form is presented which is arranged into two parts covering respectively the periods of 1952 through 1957 and of 1958 through March 1963. Coordinate indexes are included. (D.L.C.)

12738 EFFECT OF IRRADIATION ON THE VOLUME AND MECHANICAL RESISTANCE OF CRYSTALLINE CERAMIC SOLIDS PREPARED FROM FUSED SILICATES. Stelian N. Lungu (Inst. of Atomic Physics, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 14: 815-17(1963). (In Rumanian)

Samples obtained from the crystallization of aluminosilicates of Mg, Ca, and Na containing fluorine were exposed to neutron fluxes up to 3×10^{18} n/cm^2. The phase composition is fine crystals of the (Na, Ca) (Mg, Al)$_{2\ldots3}$ [$AlSi_3O_{10}/F_2$] and a glass of complex alumino-silicates. The variations of volume caused by tempering thermal treatments in samples previously irradiated were determined; values of the order of magnitude of the experimental errors, i.e., about 0.02%, were found. The irradiation does not sensibly affect the resistance to bending of the materials studied. (tr-auth)

12739 SELECTED PROPERTIES OF NEUTRON IRRADIATED DIAMOND. Reynolds M. Denning (Univ. of Michigan, Ann Arbor). Am. Mineralogist, 49: 72-105(Jan.-Feb. 1964).

An investigation of the grinding hardness of large single crystal diamonds in selected crystallographic directions as a function of the amount of fast neutron irradiation up to 10^{18} nvt (fast) was made. Further studies of other physical properties include cleavage, density, x-ray diffraction, piezobirefringence and index of refraction, and optical absorption. In each phase of the work, studies were made of irradiated and non-irradiated diamonds, and in some cases, of annealed diamonds. It was concluded that displaced carbon atoms accumulate in the interstitial zones of amorphous carbon between mosaic blocks of diamond that contain randomly distributed vacancies and some interstitial carbon atoms. Annealing to 600°C permits at least some of the interstitial carbon atoms to return to normal structural sites, but the carbon in the amorphous intermosaic zones does not return to the vacancies. (auth)

12740 THE JOINT ACTION OF SURFACE-ACTIVE LIQUID METALS AND OF RADIATION ON SINGLE CRYSTALS OF ZINC. O. A. Troitskii and V. I. Likhtman. At. Energ. (USSR), 15: 523-6(Dec. 1963). (In Russian)

It is known that thin layers of surface active liquid metals covering a higher-melting base metal reduce the strength and the plasticity of the latter. This problem was studied further by exposing 10-mm long and 1-mm wide Zn single crystals to α, β, proton, and neutron bombardment while covered with a 5-micron thick layer of Hg, amounting to about 1 weight % of the system. As

a general rule, a strengthening was observed at first, followed by a reduction of the strength. It was concluded that the radiation first intensifies the amalgamation process and accelerates the penetration of Hg into the Zn; thus the initial radiation strengthening is counteracted by the effect of the amalgamation, causing ultimately the weakening of the Zn. The radioinduced alloying results in the formation of crystal defects. X-ray diffraction pictures also pointed toward the enhancement of the diffusion process which finally caused the coalescence of the structural defects. (TTT)

12741 ELECTRICAL CONDUCTION IN IRRADIATED PYROLYTIC GRAPHITE. A. Ammar and D. A. Young (Imperial Coll. of Science and Tech., London). Brit. J. Appl. Phys., 15: 131-41(Feb. 1964).

Fast neutron irradiation at about 20°C to a dose of 10^{18} neutrons per cm^2 reduces the a-axis conductivity of recrystallized pyrolytic graphite by a factor of about 3.1, but increases the c-axis conductivity by a factor of about 5.2. Using the conductivity in these two directions as an indicator, the annealing behavior was studied by a combination of isochronal and isothermal techniques up to 1350°C. The annealing kinetics found are similar to data reported for reactor grade graphite, but data on the resistivity–temperature characteristics for various degrees of residual damage are found to be useful in discussing the electric properties of disordered pyrolytic graphites. In particular it appears that interstitial atoms assist conduction in the c-axis, but reduce a-axis conductivity up to 800°K, whereas vacancies exert a dominant effect only below 400°K. (auth)

12742 OPTICAL AND THERMAL BLEACHING OF COLOR CENTERS PRODUCED IN DOPED SILICA BY X RADIATION. Sabatino Cohen and Monique Priqueler (Centre de Recherches de la Compagnie de Saint-Gobain, Paris). Compt. Rend., 258: 877-9(Jan. 20, 1964). (In French)

A possible relation between the absorption bands and thermoluminescence peaks that appear after x irradiation of vitreous silica doped with aluminum was investigated, together with the centers responsible for the phenomena. Bleaching of the peaks by heating and by ultraviolet irradiation, independently and in succession, was used. (D.C.W.)

12743 MAGNETIC PROPERTIES OF AN IRON–NICKEL SINGLE CRYSTAL ORDERED BY NEUTRON BOMBARDMENT. L. Néel, J. Pauleve, R. Pauthenet, J. Laugier, and D. Dautreppe (Centre d'Etudes Nucleaires et Laboratoire d'Electrostatique et de Physique du Metal, Grenoble, France). J. Appl. Phys., 35: 873-6(Mar. 1964).

It is shown that a new ordered structure can be obtained in an Fe–Ni (50%–50%) alloy by irradiating it with neutrons below 320°C. This ordered structure is tetragonal (AuCu type) and leads to a very high-magnetic anisotropy. The magnetic properties of a single-crystal disk irradiated with neutrons at 295°C, with an applied magnetic field along the [100] direction, were studied. The x-ray super-lattice lines show that after irradiation the sample is made of small ordered crystallites with their tetragonal axes distributed along a [100], [010], or [001] direction. The study of the anisotropy energy in the sample plane [011], and the magnetization curves drawn for different directions, show that this sample presents the characteristics of a uniaxial substance. But if, in a classical way, the anisotropy energy is expressed by $K_1 \sin^2\theta + K_2 \sin^4\theta$, it is found experimentally $K_1 = 3.2 \cdot 10^6$ ergs/cm^3 and $K_2 = 2.3 \cdot 10^6$ ergs/cm^3. The high value of K_2 is not in agreement with the conception of independent crystallites. A theory taking into account the exchange interaction between the crystallites that are in fact smaller than the magnetic domains is developed. The formulas obtained in this way give a good agreement with the experimental results. (auth)

12744 IRRADIATION OF IRON AND 5-79 Mo PERMALLOY WITH 2-Mev ELECTRONS. D. I. Gordon and R. S. Sery (Naval Ordnance Lab., Silver Spring, Md.). J. Appl. Phys., 35: 879-80(Mar. 1964).

Large changes in the structure-sensitive magnetic properties of bulk polycrystalline 5-79 Mo Permalloy resulted from irradiation with 2-Mev electrons at ~10^{17} electrons/cm^2 at temperatures ranging from 60 to 170°C. These changes showed an approximately linear dependence on sample thickness of 0.10 to 0.25 mm. In addition, extreme rectangularities in the magnetization curves and hysteresis loops were obtained. For example, the maximum slope of the magnetization curve for a 0.10-mm sample increased from $\Delta B/\Delta H = 0.3 \times 10^6$ to 4.3×10^6. This unusual steepness is evidence of the effectiveness of electron irradiation in influencing order in 5–79 Mo Permalloy at temperatures well below the ordering temperature, and without an applied magnetic field. Iron, irradiated under the same conditions, showed no changes in its magnetic properties. (auth)

12745 ELECTRON MICROSCOPE STUDY OF STRUCTURE DEFECTS IN IRRADIATED BERYLLIUM OXIDE. A. Bisson (CEN, Saclay, France). J. Nucl. Mater., 10: 321-328(Dec. 1963). (In French)

Irradiated beryllium oxide was examined by electron microscopy, by means of a method that permits study of samples in which structural damage prevents fractographic examination. Irradiation reduces intergranular cohesion and the beryllium oxide crystallites are honeycombed by groups of point defects that greatly perturb the lattice. Examination of samples annealed at 900–1500°C after irradiation confirmed that these defects group themselves in linear arrays of small loops, which gradually become elongated in the basal plane of the crystal. Microhardness measurements suggest that dislocations, if indeed they continue to exist, become much less mobile after irradiation. (auth)

12746 SWELLING OF URANIUM ON POSTIRRADIATION ANNEALING. B. A. Loomis and D. W. Pracht (Argonne National Lab., Ill.). J. Nucl. Mater., 10: 346-59 (Dec. 1963).

The swelling of uranium on postirradiation annealing was investigated by utilizing density measurements in conjunction with the observation of pores in the microstructures of annealed specimens. Specimens were irradiated to about 0.3% burnup in a constrained condition at approximately 275°C and were subsequently pulse annealed. The amount of swelling was found to be less than 1.1% for specimens that were annealed up to 75 hours at temperatures below 550°C; the amount of swelling, however, increased considerably on annealing at temperatures between 550 and 650°C. Specimens annealed up to 75 hours at 618°C decreased in density approximately 18%. The swelling was accompanied by the formation of bubbles on grain boundaries in recrystallized regions. The observations suggest that recrystallization is a necessary prerequisite for pronounced swelling in the alpha phase. Uranium specimens annealed up to 75 hours at temperatures between 650 and 750°C in the beta phase decreased in density about 5%. Specimens annealed in the beta phase, in contrast to those annealed at 618°C in the alpha phase, were badly cracked and contained pores of a smaller diameter, which were uniformly dis-

tributed within the grains. A specimen annealed up to 16 hours at 822°C decreased in density about 20%. Heat treatment produced pores of large diameter located along grain boundaries as well as pores of smaller diameter distributed uniformly within the grains. (auth)

12747 TRANSITION RADIATION FROM NiO, CoO AND MnO. Shoji Tanaka and Yoshifumi Katayama (Tokyo Univ.). J. Phys. Soc. Japan, 19: 40-5(Jan. 1964).

The visible radiation emitted from the single crystals of NiO, CoO, and MnO by the fast electron bombardment is investigated. The spectral distributions, the angular distributions of the intensity, and the polarization characteristics of the emitted light were measured. The experimental results are discussed in view of the theoretical prediction of the transition radiation as well as other possibilities caused by the fast electron bombardment. It is concluded that this radiation is the transition radiation predicted by Frank and Ginsburg. (auth)

12748 RADIATION-INDUCED PHASE TRANSFORMATIONS. O. Hauser and M. Schenk (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Kernenergie, 6: 655-67 (Dec. 1963). (In German)

Thermodynamic and structural principles of the modification changes brought about in heat-induced and radioinduced phase transformations are discussed. Transformations in solid crystalline phases were considered for heteropolar and homopolar compounds, metals, and alloys. Point defects and displacement spikes that appear in solids on irradiation are discussed. (M.C.G.)

12749 STUDIES ON X-AGENT. XV. EFFECT OF X-AGENT ON THE TRANSMITTANCE OF FROSTED GLASS SURFACE. Hideo Moriyama (Shonan Hygiene Inst., Kamakura, Japan). Yokohama Med. Bull., 13: 103-26(Apr. 1962).

The effect of a postulated, unidentified physical factor, possibly of cosmic origin, on the optical properties of glass is reported. It was found that the transmittance of the frosted glass surface of a photometer absorption cell was altered when the cell was placed close to a lead pile or to a water bottle. The change was transient, so that in a few minutes the original transmittance values were recovered. The change could be induced within 10 minutes after the cell was so situated. The change in transmittance was most manifest in cells placed on the north side of the material tested. If two or more cells were placed side by side around the material, similar changes took place at the same time in all cells. The change around a water bottle was different in intensity depending on the quantity of water it contained; a larger quantity of water caused a greater change. The change failed to occur when the cell was placed at a distance from the materials tested. The change could be observed only on some days and generally at certain periods of these days. Long periods extending for several months, in which no change was demonstrable were recorded. No analogous changes could be induced by an artificial alteration of conditions, including those of temperature and light, under which the cells were placed. (BPB)

12750 TRANSISTOR IRRADIATION EFFECTS—THE PHYSICS AND ENGINEERING IMPLICATIONS. Leonard B. Gardner and James R. Coss. p.65-8 of "Institute of Environmental Sciences, 1963 Annual Technical Meeting Proceedings." Mt. Prospect, Ill., Institute of Environmental Sciences, 1963.

The basic mechanisms of radiation damage to semiconductors are considered, and specific examples of transistors are presented. It is shown that under certain conditions of irradiation almost all of the radiation-produced damage annealed, or self healed, in a period of time following irradiation. The mechanisms of this healing are discussed. It is also shown that a portion of the radiation produced damage did not heal. Experimental evidence from neutron irradiation of transistors is presented concerning both the healing of damage and permanent damage. A theoretical argument is presented relating the neutron physics of failure to that of protons as well as other types of radiation. (auth)

12751 PERMANENT RADIATION EFFECTS IN SEMICONDUCTOR DEVICES. Robert S. Caldwell (Boeing Co., Seattle). p.145-51 of "Institute of Environmental Sciences, 1963 Annual Technical Meeting Proceedings." Mt. Prospect, Ill., Institute of Environmental Sciences, 1963.

The mechanisms for defect production, the resultant changes in the basic semiconductor properties, and the effects of such property changes on the operation of each specific class of semiconductor device are discussed. (auth)

12752 RADIATION EFFECTS ON CAPACITORS AND DIELECTRIC MATERIALS. Donald J. Hamman (Battelle Memorial Inst., Columbus, Ohio). p.553-60 of "Institute of Environmental Sciences, 1963 Annual Technical Meeting Proceedings." Mt. Prospect, Ill., Institute of Environmental Sciences, 1963.

Transient and permanent radiation effects on organic and inorganic electrical insulation materials are discussed. Radiation effects on capacitor dielectrics of glass and vitreous enamel, mica, ceramics, paper, plastics, and electrolytes are discussed. 19 references. (R.E.U.)

12753 VAN ALLEN RADIATION AND EFFECTS ON SOLAR CELLS. Joseph F. Weller (Naval Research Lab., Washington, D. C.). p.621-4 of "Institute of Environmental Sciences, 1963 Annual Technical Meeting Proceedings." Mt. Prospect, Ill., Institute of Environmental Sciences, 1963.

Radiation environment in space is described, and the basic mechanisms of radiation damage as well as the results of significant radiation damage experiments on solar cells are presented. Solar cells are among the more important components of a satellite because they provide the electrical power for the operation of the satellite's electronics. Because of their semiconductor properties, the cells are readily damaged by protons and electrons, and this damage is enhanced since they are surface-mounted and do not have the satellite skin to protect them. In the face of these problems, actual and potential measures to improve the radiation resistance of the solar cell system are described. (auth)

12754 RADIATION DAMAGE EFFECTS IN URANIUM CARBIDE. B. G. Childs and J. C. Ruckman (Dounreay Experimental Reactor Establishment, Caithness, Scotland). p.1-17 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. II." Vienna, International Atomic Energy Agency, 1963.

Results are reported of research into the irradiation behavior of cast uranium carbide following that reported in another paper by Childs et al. The main conclusions are as follows: 1. The saturation resistivity and lattice parameter increases for hypostoichiometric specimens irradiated at 80°C vary systematically with the excess concentration of uranium present in solution in the UC phase. 2. The temperature coefficient of resistivity (measured over the range 77 to 293°K), unlike the re-

sistivity itself, is not significantly affected by irradiation. 3. A small resistivity annealing stage, additional to those at 150 and 510°C, occurs between 1000 and 1200°C. The annealing-out of the lattice parameter change also occurs in two main stages at 150 and 510°C (5-hr anneals). A careful survey of the range 400 to 800°C has failed to reveal the stage postulated by other workers to occur at about 710°C. The significance of the results in determining the defect structure of irradiated uranium carbide is discussed. (auth)

12755 UTILIZATION OF HOT-PRESSED BERYLLIUM OXIDE BRICKS AS NEUTRON REFLECTORS. R. Beaugé, J. Elston, R. Roulliay, and M. Simbozel (Centre d'Etudes Nucléaires, Saclay, France). p.497-509 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. II." Vienna, International Atomic Energy Agency, 1963. (In French)

A study of the effects of neutron irradiation on the physical properties and mechanical characteristics of beryllium oxide shows the great importance of three factors: irradiation temperature, density of the oxide, and shape of the grains of the sintered compacts. These conclusions determine how this refractory substance will be used as a moderator in reactors operating at high temperature. There is a critical decline in the mechanical characteristics of the dense beryllium oxide compacts following irradiation of the order of 2×10^{20} n_f/cm^2 (E > 1 Mev) at below 100°C. However, the behavior of hot-pressed beryllium oxide bricks used as a reflector in a swimming-pool reactor was studied. For this purpose, tight aluminium vessels containing compacts of high density (~2.9) were constructed and three of them—about 150 kg of beryllium oxide—formed part of the reflector of the Triton swimming-pool reactor. In stable operation, the power of this reactor is 2 Mw. The instantaneous fluxes reaching the surface of the vessel closest to the core are 2×10^{13} n_{th}/cm^2 sec and 10^{12} n_f/cm^2 sec, respectively. The temperature measurements made under these conditions gave 70°C for the hottest points of the compacts. The most heavily irradiated vessel remained in service for 11,495 hr. The condition of the bricks after being so used is described. (auth)

12756 RESULTS OF RADIATION TESTS ON MATERIALS AND COMPONENTS FOR NUCLEAR ROCKET APPLICATIONS. A. O. Burford (Lockheed-Georgia Co., Marietta). 19p. (CONF-187-66)

From American Nuclear Society Meeting, New York, Nov. 1963.

Tests conducted on radiation rate-induced effects in electrical cables, as part of the NASA-RIFT program, are reported. Tests were performed on coaxial, twisted pair, twinaxial, and four-wire cables with dielectrics of polyethylene, Teflon, polyvinyl chloride, and glass to determine leakage conductance, d-c generation, audio and r-f noise, capacitance, and dissipation factor. Dose rates were 10^4 to 2×10^8 r/hr at 14 to 70°C. (R.E.U.)

12757 THE RADIATION ENVIRONMENT IN SPACE AND ITS EFFECTS ON MATERIALS. V. J. Linnenbom (Naval Research Lab., Washington, D. C.). 46p. (CONF-375-6)

From 6th National Symposium Society for Aerospace Material Process Engineers, Seattle, Nov. 1963.

The nature of the naturally occurring radiation environment in space is described. Included are the nuclear explosion-produced electrons. The effects of this environment on components to be used in space vehicles are studied. The effects on organic polymers and semiconductors are also discussed. (R.E.U.)

12758 ANNEALING OF RADIATION DAMAGE IN SPACE. Daniel Binder (Hughes Aircraft Co., Fullerton, Calif.). 8p. (CONF-166-12)

From American Society for Testing Materials 66th Annual Meeting, Atlantic City, June 1963.

First- and second-order annealing during irradiation are considered with application to the radiation damage in space vehicles. A jump-frequency formula is given. (R.E.U.)

12759 RADIATION EXPOSURE UNIT. Donald L. Snyder and Richard G. Teske (to Minnesota Mining and Mfg. Co.). U. S. Patent 3,123,700. Mar. 3, 1964. Filed Mar. 28, 1960.

An apparatus is described for exposing whole sheets of materials to intense radiation with no mechanical gripping (instead using a vacuum suction device). (R.E.U.)

METEOROLOGY

12760 (AD-412528) INVESTIGATION OF THE QUANTITATIVE DETERMINATION OF POINT AND AREAL PRECIPITATION BY RADAR ECHO MEASUREMENTS. Sixth Quarterly Technical Report January 1, 1963–March 31, 1963. E. A. Mueller and G. E. Stout (Illinois. State Water Survey. Meteorologic Lab., Urbana). Contract DA-36-039 SC-87280. 19p.

Data on raindrop-size distribution in various parts of the world will be correlated with appropriate radar parameters in order to improve the capability of radar in measuring surface rainfall intensities for Army applications such as radioactive rainout prediction, trafficability, and communications. (auth)

12761 (ANL-6794) A LABORATORY INVESTIGATION OF THE LAGRANGIAN AUTOCORRELATION FUNCTION IN A STRATIFIED FLUID. Paul Frenzen (Argonne National Lab., Ill.). Nov. 1963. Contract W-31-109-eng-38. 185p.

Thesis submitted to Univ. of Chicago.

An experimental investigation of turbulent diffusion in a towing channel is described. Measurements of consecutive displacements of tracer particles suspended within grid-produced fields of homogeneous turbulence were corrected for decay and used to compute Lagrangian autocorrelation functions. Results in the form of correlograms and a number of turbulence characteristics obtained under conditions of three different initial turbulence intensities (i.e., three grid Reynolds numbers) in fluid stratifications ranging from weak instability to strong stability are compared. By introducing a Richardson number of turbulence, the model is shown to be similar to prototype atmospheric motions of the order of small-scale eddy-diffusive circulations at stack height in conditions of slight to moderate stability. The results obtained demonstrate the feasibility of employing decay-corrected observations of homogeneous turbulence produced in the lee of rectangular grids for model studies of diffusion; they further suggest the usefulness of the Richardson number of turbulence and the Brunt-Vaisala stability parameter (N^2) for this purpose. (auth)

PHYSICS

General

12762 (AD-406214) SURFACE IONIZATION OF LITHIUM FLUORIDE AND THALLIUM ON TUNGSTEN, RHENIUM, AND PLATINUM SURFACES. Special Technical Progress Report No. 1. Svein G. Andresen (Colorado. Univ., Boulder). Mar. 1963. Contract DA 36-039 SC-87277. 67p.

Ionization efficiencies of lithium, lithium fluoride, and thallium on hot tungsten, rhenium, and platinum surfaces were studied using molecular beam techniques. The temperature dependence of the efficiencies as well as aging effects of the filaments used were determined. Careful design of the apparatus allowed pressures of the order of 5×10^{-9} mm Hg to be maintained at the detector contributing to the degree of cleanliness of the hot surfaces. As a by-product of the efficiency measurements, vapor pressure data, and estimated molecular scattering cross sections for LiF, Li, and Tl were obtained. Signal-to-noise ratios were estimated from the recordings made. (auth)

12763 (AFCRL-63-672) SEISMIC STUDIES AND EXPERIMENTAL EVALUATIONS. Final Report. David E. Willis and James T. Wilson (Michigan. Univ., Ann Arbor. Inst. of Science and Tech.). June 1963. Contract AF19 (604)-6642. 30p. (AD-408773)

A summary is presented of an extensive three-year field measurement and data analysis program that was conducted to investigate the frequency and energy spectra, amplitude, and attenuation of seismic signals generated by quarry shots, underwater chemical shots, underground nuclear detonations, and earthquakes. A statistical study of earthquake and nuclear-explosion data revealed that particle-velocity ratios of the maximum shear-surface waves to compressional waves can be used as an aid in distinguishing between these two types of sources at distances of less than 1000 km. Differences in amplitude, spectra, and energy content of seismic waves were found that could be attributed to source size, depth of source, time duration of source, geological environment at the source and recording station, and azimuthal effects around the source. Since some of the data overlap and conflict, it is difficult to positively differentiate one effect from another. Further investigations of these effects are needed to delineate the useful applications of frequency and energy data for discrimination purposes. (auth)

12764 (IS-615) LIFT COEFFICIENTS OF SPHERES MOVING IN CIRCULAR TUBES. Richard Allan Hendrickson and Glenn Murphy (Ames Lab., Ames, Iowa). Nov. 1962. Contract W-7405-eng-82. 58p.

The effect of viscosity, velocity, and diameter ratio on the lift coefficient of a spherical particle moving in a circular tube was determined experimentally, and a prediction equation for the lift coefficient in terms of these variables was derived. Within the range of particle Reynolds numbers (200 to 550) investigated, the lift coefficient is inversely proportional to viscosity and varies exponentially with the diameter ratio. (auth)

12765 (LA-2980) HUG, A FORTRAN–FAP CODE FOR COMPUTING NORMAL SHOCK AND DETONATION WAVE PARAMETERS IN GASES. Paul F. Bird, Russell E. Duff, and Garry L. Schott (Los Alamos Scientific Lab., N. Mex.). Sept. 11, 1963. Contract W-7405-eng-36. 69p.

The HUG program permits the solution of the Rankine-Hugoniot equations for normal shock waves in ideal gas mixtures for many sets of conditions. Provision is also made for considering chemical equilibrium problems independent of shock wave occurrence. The equations, input, output, and operation are discussed; and some applications in equilibrium situations are considered. The program is in FAP and FORTRAN II for IBM 7090 and 7094 computers under the MONITOR system. (D.C.W.)

12766 (NP-13566) ANALOG STUDIES OF UPSTREAM-INCLINED WAVES IN MAGNETO-GASDYNAMIC FLOW. Lawrence S. Iwan (Cornell Univ., Ithaca, N. Y. Graduate School of Aerospace Engineering). Dec. 1963. 38p.

An analog was devised to study two-dimensional magnetogasdynamic flow for the case of aligned magnetic and velocity fields and a perfectly-conducting compressible fluid. The analog consists of stretched elastic sheets in an incompressible fluid. The elastic sheets are analogous to a magnetic field and produce a body force on the fluid when displaced from their equilibrium positions. The differential equations describing the system are the same as the magnetogasdynamic equations for the case cited, except for the expression for the body force in the momentum equations. It is just this difference which makes it possible to simulate some of the features of compressible MHD flows using an incompressible fluid. Analysis of the analog system reveals striking similarities between the small disturbance propagation characteristics of that system and magnetogasdynamics. In particular, it is shown that it is possible to simulate the conditions under which forward-inclined disturbance waves are predicted in magnetogasdynamics flows about bodies. An experiment was performed in which a body was towed along a tank filled with water in which sheets of natural rubber had been stretched to simulate a uniform magnetic field. Upstream-inclined waves were observed, whose angles with the direction of the body's motion agreed well with the predicted values. (auth)

12767 (TID-20197) F-BAND SHAPE IN THE CsCl STRUCTURE UNDER PRESSURE. D. B. Fitchen (Illinois. Univ., Urbana). Jan. 1964. Contract [AT(11-1)-1198]. 19p.

Color centers have been formed by x-irradiation of RbCl above the polymorphic transition pressure, and the shape of the new F band at 509 mμ in this CsCl-type structure has been examined under a pressure of 6200 atmospheres at liquid helium temperature. The band shows no evidence of the multiplet structure observed in the cesium halides, thus indicating that the lattice structure is not responsible for this effect. The F band in CsCl has also been formed and studied under pressure at helium temperature, and the triplet components show the usual relative intensity and the characteristic F-band shift. No evidence of K' bands was observed for these hydrostatic pressures. (auth)

12768 CALCULATION OF THE TRAJECTORIES OF CHARGED PARTICLES IN THE FIELD OF A MAGNETIC PRISM. I. Ringhiopol (Inst. of Atomic Physics, Bucharest. Acad. Rep. Populare Romine, Studii Cercetari Fiz., 14: 775-81(1963). (In Rumanian)

A method for the calculation of the trajectories of charged particles in the field of a magnetic prism is proposed. The practical results obtained in the case of a distribution of a given field are indicated. (tr-auth)

12769 THEORETICAL STUDY OF FORCED SINUSOIDAL OSCILLATIONS BETWEEN INDEFINITE PARALLEL PLANES OF AN ELECTRICALLY CONDUCTIVE FLUID IN A TRANSVERSE MAGNETIC FIELD. Etienne Crausse, Yves Poirier, and Charles Vives (Faculte des Sciences, Besancon, France). Compt. Rend., 258: 809-12 (Jan. 20, 1964). (In French)

The variations of the average velocity and the phase difference for various values of the fundamental parameters were obtained. (tr-auth)

12770 WORK FUNCTION OF THE (110) FACE OF TANTALUM IN A CESIUM VAPOR. W. T. Norris (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 35: 467-9(Mar. 1964).

The effective work function of the (110) face of a crystal of tantalum in the presence of cesium was estimated from values of the saturated electron emission deduced from the characteristics of a diode. The temperature of the cesium reservoir ranged from 320 to 380°K and the emitter temperatures were in the range 1100 to 1350°K. Under these conditions the work function of the cesium-covered surface was about 0.3 ev lower than that of polycrystalline material under similar conditions. (auth)

12771 CLEAN UP OF INERT GASES IN A PENNING DISCHARGE STUDIED BY A TRACER TECHNIQUE. Koji Kawasaki, Toshio Sugita, Isao Kohno, Jiro Watanabe, and Nobuyuki Hayashi (Electrotechnical Lab., Tokyo). J. Appl. Phys., 35: 479-82(Mar. 1964).

In order to obtain further information on the pumping action of a diode getter ion pump for inert gases, the cleanup of inert gases, principally the ion sputtering patterns on the cathode and the location of ions on each electrode, was observed for pumps with various cells by the use of radioactive tracer Xe^{131m}. The radioactivity of each electrode was counted by a GM counter. Inert gases are cleaned up principally at the cathode; about 20% as much is cleaned up at the anode. (auth)

12772 SECONDARY POSITIVE ION EMISSION FROM A TANTALUM SURFACE. James A. McHugh and James C. Sheffield (Knolls Atomic Power Lab., Schenectady, N. Y.). J. Appl. Phys., 35: 512-15(Mar. 1964). (TID-19245)

The secondary positive ions ejected from a tantalum target by a mass-analyzed primary beam were detected and studied in a mass spectrometer. The secondary ion emission consisted of species characteristic of the metal (Ta^+), metal compounds (oxides), and multiatomic ions of the metal (Ta_2^+,Ta_3^+). Reflection of normally incident gas ions from the Ta surface was not observed; the specular reflection coefficient of ions to ions is then less than 10^{-4}. The relative secondary ion yields for tantalum, measured for normally incident Hg^{202} ions at energies between 0.3 and 14 kev, were independent of the incident ion charge. A dependence of the Ta^+ secondary yield on mass of the incident ion was observed. The dependence of the secondary ion yield on mass and energy of the incident ions was very similar to that observed for total sputtering yields. (auth)

12773 X-RAY-INDUCED DISLOCATION GENERATION IN SODIUM CHLORIDE. Robert L. Wolfe and Charles L. Bauer (Carnegie Inst. of Tech., Pittsburgh). J. Appl. Phys., 35: 658-63(Mar. 1964).

The strain distribution, induced by subjecting one-half of a sodium chloride single crystal to x rays while shielding the other half, was investigated with a dislocation etch pit technique. Due to the expansion of the irradiated half, a strain gradient arises antisymmetrically about the plane of the interface that is sufficient in magnitude to cause plastic deformation in the protected half, but not in the irradiated half of the crystal. The plastic deformation takes the form of a number of high-density dislocation bands that tend to align in a [100] direction. The bands increase in number but not appreciably in size as irradiation proceeds. The absence of plastic deformation in the irradiated half can be explained by the fact that irradiation raises the yield strength to such a level that the strain is not sufficient to induce plastic flow. In the protected region, however, dislocations are generated and glide until they impinge, causing discrete bands to form roughly parallel to (100) planes. From an analysis of the data, an estimate of the magnitude of the strain produced at the interface and the relationship between the strain and the number of F centers generated can be obtained. The results, although in some ways unexpected, are consistent with previous experiments performed on x-irradiated alkali halides. (auth)

12774 TWO PHOTOMECHANICAL EFFECTS IN ALKALI HALIDE CRYSTALS. J. S. Nadeau (General Electric Research Lab., Schenectady, N. Y.). J. Appl. Phys., 35: 669-77(Mar. 1964).

Two photomechanical effects, observed in alkali halide crystals containing color centers, appear as sudden reversible changes in flow stress when a crystal is illuminated. Both effects are related to optical transitions of the F center. In potassium chloride, intensely illuminated at 175°K, hardening appears to be caused by the $F \rightarrow F'$ process. Below 80°K, in KCl, even more severe hardening is caused upon illumination, by transport of the F-center electron to an unspecified trap lying very close to the conduction band; decay of the hardening after extinction of the exciting light requires several seconds and may be caused by dislocation-point defect interactions. The effects were observed in nine of the alkali halides. Flow stress increases and decreases were both observed, depending upon the particular alkali halide. (auth)

12775 NEUTRON DIFFRACTION EFFECTS WITH MOVING LATTICES. C. G. Shull and N. S. Gingrich (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 35: 678-82(Mar. 1964).

Observations are reported on the effect of specimen motion upon the neutron diffraction pattern of iron. Specimen speeds of 120 m/sec combined with a neutron speed of 3310 m/sec are found to produce easily measured angular shifts, integrated intensity changes, neutron wavelength alteration, and peak width changes, all of which are dependent upon the direction of motion relative to the scattering vector. The effects can be conveniently interpreted with the reciprocal lattice construction and the calculated changes with motion agree satisfactorily with the observations. (auth)

12776 CZOCHRALSKI GROWTH OF DOPED SINGLE-CRYSTAL LANTHANUM TRIFLUORIDE (LaF_3) FOR LASERS. M. A. Hiller (North American Aviation Science Center, Canoga Park, Calif.) and O. M. Stafsudd. J. Appl. Phys., 35: 693-5(Mar. 1964).

A method of growing large, optically clear lanthanum trifluoride crystals was developed. The method is quite simple and fast in that setup time per run is considerably shorter than that required by other growth methods. (auth)

12777 THRESHOLD DISPLACEMENT ENERGIES AND SUBTHRESHOLD DISPLACEMENTS IN COPPER AND GOLD NEAR 10°K. W. Bauer and A. Sosin (Atomics International, Canoga Park, Calif.). J. Appl. Phys., 35: 703-9(Mar. 1964).

The minimum energy T_d needed to displace an atom

from its lattice position was determined. The resistivity increase as a function of integrated flux was measured at various electron energies. The damage-production curve, thus obtained, was the sum of two components. The first contribution is due to direct displacement processes. From a projection of this component to zero, it is estimated that $T_d^{Cu} = 16$ to 19 ev and $T_d^{Au} = 33$ to 36 ev. The second contribution, the subthreshold events, are due to various "soft spots" associated with unavoidable impurities in the nominally 99.999% pure copper and gold specimens. It has been shown that displacements near dislocations do not contribute in a significant manner. It was further shown that the formation of light-atom interstitials can contribute to subthreshold processes. While this does not conclusively prove that subthreshold processes in nominally pure copper and gold are due to the presence of light-atom impurities, this is believed to be the most probable subthreshold mechanism. (auth)

12778 EFFECT OF PARTITION FUNCTION CUTOFF UPON THE THERMODYNAMIC PROPERTIES OF ATOMIC HYDROGEN AND HELIUM TO 100000°K. J. Charles Hester and Kenneth G. Sewell (LTV Research Center, Dallas). J. Appl. Phys., 35: 729-30(Mar. 1964).

The effects of terminating the sum contained in the partition function used to calculate thermodynamic properties of high-temperature gases are reported for atomic hydrogen and helium. The results show that for low and intermediate densities, the thermodynamic properties are independent of the cutoff point. (R.E.U.)

12779 SPIN-WAVE EXCITATION IN CUBIC RARE-EARTH COMPOUNDS. Noboru Tsuya (Naval Ordnance Lab., White Oak, Silver Spring, Md. and Univ. of Maryland, College Park) and Yoshio Ebina. J. Appl. Phys., 35: 800-1(Mar. 1964).

Some of the cubic rare-earth compounds are ferromagnetic at low temperatures. However, the observed magnetic moment is much smaller than it is for the free ion because of the effect of the strong crystalline field on the trivalent rare-earth ions. Solving the one-ion Hamiltonian numerically, approximate ferromagnetic spin wave states of an unusual nature, in that they involve ionic states of orbital as well as spin angular momentum in both a crystalline and an exchange field are constructed. From the excitation spectrum of these states, the temperature dependencies of the specific heat, strong-field susceptibility, and g factor of a ferromagnetic array of trivalent rare-earth ions are calculated, and the behavior of HoN and TbN are predicted. (auth)

12780 FERROMAGNETIC EUROPIUM COMPOUNDS. T. R. McGuire and M. W. Shafer (IBM, Yorktown Heights, N. Y.). J. Appl. Phys., 35: 984-8(Mar. 1964).

Ferromagnetism has been found in several divalent europium compounds. Some of these materials are particularly simple in both crystal and magnetic structure and are ideal for experimental and theoretical study. Magnetic information on europium chalcogenides, europium halogens, and europium silicates are summarized and theoretical results reviewed. (auth)

12781 CRYSTAL GROWTH AND MAGNETIC SUSCEPTIBILITIES OF SOME RARE-EARTH SODIUM MOLYBDENUM SCHEELITES. M. Schieber and L. Holmes (Harvard Univ., Cambridge, Mass.). J. Appl. Phys., 35: 1004-5(Mar. 1964).

The composition range for growing tetragonal scheelite-type single crystals was investigated and located on the ternary diagram $Gd_2O_3-MoO_3-Na_2O$. Single crystals, the largest one weighing more than 1.2 g, and having a composition of $R_{0.5}Na_{0.5}MoO_4$, with R = Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, and Yb, were grown by slowly cooling the ternary melts from 1000°C with rates at 1.1 to 3.2°C/h. The crystals were leached out of the flux by boiling them with NH_4OH. The various colored transparent pyramidal crystals have their tetragonal "c" axis perpendicular to the pyramidal base. The unit cell dimensions of the individual crystals are given. The magnetic susceptibilities of the scheelites of Gd and Dy are reported between 3 and 300°K. Dy or Gd scheelite did not show an ordinary ordering temperature above 1.8°K. (auth)

12782 FERROMAGNETISM IN RARE-EARTH GROUP VA AND VIA COMPOUNDS WITH Th_3O_4 STRUCTURE. F. Holtzberg, T. R. McGuire, S. Methfessel, and J. C. Suits (IBM, Yorktown Heights, N. Y.). J. Appl. Phys., 35: 1033-8(Mar. 1964).

The bcc structure $I\bar{4}3d-T_d^4(Th_3P_4)$ occurs as a defect structure in 2:3 compounds of rare-earth elements with S, Se, and Te, or as an inverted structure in 4:3 compounds with group VA elements. The structural, electric, and magnetic properties of the metallic 4:3 compounds and the 2:3 rare-earth semiconductors were investigated with specific reference to gadolinium, for which the S ground state gives the minimum crystal field effect. (auth)

12783 AN EXPRESSION FOR THE CHANGE OF ELECTRON ENERGY THROUGH DEFECTS IN METALS. E. Mann (Technische Hochschule, Stuttgart and Max-Planck-Institut für Metallforschung, Stuttgart). Phys. Letters, 8: 97-8(Jan. 15, 1964). (In German)

A method is discussed that permits the determination of the energy changes for any disturbed potential and energy level in the one-electron approximation for a metal. The Born approximation is utilized to obtain a simplified expression. (R.E.U.)

12784 HYPERFINE STRUCTURE IN THE LINE 4922 Å (2^1P-4^1D) IN He^3. J. M. Vaughan (Oxford Univ.). Phys. Letters, 8: 111-12(Jan. 15, 1964).

Factors affecting the line profiles in the 4922 Å line from He^3 and 5048 Å line in He^4 are discussed. A comparison is made between profiles of 5048 Å (2^1P-4^1S) and the 4922 Å line in order to detect hfs of ~600 Mc/s. A microwave discharge cooled with liquid helium to 9°K was used. (R.E.U.)

12785 MÖSSBAUER EFFECT FOR Fe^{57} IN BERYLLIUM, COPPER, TUNGSTEN, AND PLATINUM. J. P. Schiffer, P. N. Parks, and Juergen Heberle (Argonne National Lab., Ill.). Phys. Rev., 133: A1553-7(Mar. 16, 1964).

The Mössbauer effect was studied for Fe^{57} as an impurity in Be, Cu, W, and Pt. The positions of the resonances and the ratios of recoilless fractions at different temperatures were determined. The behavior of these quantities as a function of temperature indicates the approximate correctness of the simple expectation that the impurity should behave as if it were in a solid composed only of the impurity atoms with a Debye temperature given by $\Theta_{eff} = (M_{host}/M_{impurity})^{1/2}\Theta_{host}$. (auth)

12786 SHIELDING AND DISTORTION OF RARE-EARTH CRYSTAL FIELD SPECTRA. R. E. Watson (Bell Telephone Labs., Murray Hill, N. J. and Univ. of Uppsala) and A. J. Freeman. Phys. Rev., 133: A1571-84(Mar. 16, 1964).

The electronic spectra of rare earth ions in crystalline fields are generally analyzed in terms of a static crystalline field, $V_c = \Sigma_{n,m} A_n^m \gamma^n Y_n^m(\theta,\varphi)$, which acts on the open shell of 4f electrons. The contributions of the closed atomic shells to this electrostatic interaction are examined and are found to be significant in several respects; the magnitude of

the crystal-field splittings is reduced from the values obtained by considering just the 4f shell alone which supports the familiar assertion that the 4f electrons are shielded from the external crystalline field; the ordering and relative spacing of the crystal-field levels are not necessarily those implied by the 4f crystal-field matrix elements alone. It is shown that in some cases the distortion of the ion's charge distribution produces severe deviations from the 4f crystal-field level scheme predicted by V_c directly. When such nonlinear deviations occur, they make questionable the standard crystal field parametrization schemes used for fitting observed rare earth spectra. The role played by the crystal field in producing, by means of the distortion of the closed and 4f shells, and the interaction of these distortions with the open 4f shell, contributions to the magnetic (and electric) hyperfine interactions is also investigated. (auth)

12787 NUCLEAR SPIN RELAXATION IN TRANSITION METALS; CORE POLARIZATION. Y. Yafet and V. Jaccarino (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 133: A1630-7(Mar. 16, 1964).

The nuclear relaxation induced by core polarization (c.p.) in a transition metal is calculated in the tight-binding limit. It is shown that a Korringa-like relation exists between the c.p. Knight shift and the c.p. relaxation rate, but with a factor that inhibits relaxation, the numerical value of which depends on the relative weight of Γ_8 and Γ_3 orbitals at the Fermi surface. Using estimates of the hyperfine fields, the relaxation rates associated with the contact, c.p., and orbital interactions are calculated for three transition metals. It is found that all three processes make significant contributions. The agreement with the measured relaxation rates is satisfactory considering the uncertainties in the estimated numbers. (auth)

12788 Li–Mg, A NEARLY FREE-ELECTRON ALLOY. A. T. Stewart (Univ. of North Carolina, Chapel Hill). Phys. Rev., 133: A1651-3(Mar. 16, 1964).

The momentum distributions of electron-positron pairs annihilating in polycrystalline Li, $Li_{81}Mg_{19}$, and $Li_{42}Mg_{58}$ were measured. The results show that the alloy is a good, nearly free-electron metal with an electron concentration determined by counting one electron per Li atom and two per Mg atom. The data lead to speculations about the description of metallic electrons in this alloy. (auth)

12789 QUANTUM INTERFERENCE EFFECTS IN JOSEPHSON TUNNELING. R. C. Jaklevic, John Lambe, A. H. Silver, and J. E. Mercereau (Ford Scientific Labs., Dearborn, Mich.). Phys. Rev. Letters, 12: 159-60 (Feb. 17, 1964).

The quantum-mechanical interference between the currents flowing through separate Josephson junctions, in direct analogy with double-slit electron beam interference effects, is discussed. (R.E.U.)

12790 MÖSSBAUER EFFECT DATA INDEX. Issue 1. A. H. Muir, Jr., and K. J. Ando, comps. (North American Aviation, Inc. Science Center, Canoga Park, Calif.). Aug. 1963. 84p.

An index, based on IBM cards and electronic data handling techniques, is presented on published research results relating to the Mössbauer Effect, with emphasis on experimental results. The index lists the experiments first by nuclear transition, then by source material or host, and then by absorber host, and some of the results are summarized. Code numbers are used to relate the index to approximately 215 references. Some of the references are theoretical or review type. (D.L.C.)

12791 ELECTRICAL CONDUCTIVITY OF FLAMES SEEDED WITH LARGE CONCENTRATIONS OF SODIUM, BARIUM, AND STRONTIUM. G. J. Mullaney and N. R. Dibelius (General Electric Co., [Schenectady, N. Y.]). p.47-54 of "Advances in Magnetohydrodynamics." New York, The Macmillan Co., 1963.

The electric conductivity due to sodium, barium, and strontium was investigated in H_2-O_2 and $C_3H_8-O_2$ flames at a total pressure of 1 atm and the temperature range 1400 to 2200°K. Both sodium and barium have an ionization potential of approximately 5.1 ev. Flames seeded with barium acetate had a higher conductivity (an order of magnitude at 1800°K) than those with sodium hydroxide. Flames seeded with strontium also had conductivities higher than can be due to the ionization of the alkaline earth metal. The emission limit of graphite electrodes was markedly improved with barium seeded flames compared to the limit found with flames seeded with potassium. (auth)

12792 INSTITUTE OF ENVIRONMENTAL SCIENCES, 1963 ANNUAL TECHNICAL MEETING PROCEEDINGS, APRIL 17, 18, AND 19, 1963, LOS ANGELES, CALIFORNIA. Mt. Prospect, Illinois, Institute of Environmental Sciences, 1963. 688p.

Separate abstracts were prepared for 9 of the 114 papers presented under the headings of acoustics, human factors, information and specifications, laboratory management and training, low gravity, nuclear radiation, radio-frequency interference, reliability testing, shock, space environment problems, space simulation, thermal environments, and vibration. One paper was previously abstracted for NSA. (R.E.U.)

For abstracts of individual papers see: 12477, 12750, 12751, 12752, 12753, 12793, 13325, and 13326.

12793 RADIATION ENVIRONMENT FOR MANNED SPACECRAFT. S. H. Dole (RAND Corp., Santa Monica, Calif.). p.45-6 of "Institute of Environmental Sciences, 1963 Annual Technical Meeting Proceedings." Mt. Prospect, Ill., Institute of Environmental Sciences, 1963. (CONF-185-2)

The various kinds of radiations in space are discussed with a view to their effects on space missions of low and high earth orbits and lunar and interplanetary missions. (R.E.U.)

12794 THERMIONIC EMISSION FROM METAL CRYSTALS IN ALKALI METAL VAPORS. H. F. Webster and P. L. Read (General Electric Research Lab., Schenectady). 61p. (CONF-331-3)

From the Metallurgical Society of American Institute of Mechanical Engineers, Annual Meeting, Dallas, Feb. 1963.

Thermionic emission microscopes were used to evaluate the emission density from tungsten, molybdenum, tantalum, niobium, nickel, rhenium, and niobium carbide in cesium, rubidium, and potassium vapors as a function of alkali vapor pressure, emitter temperature, and emitter crystal face. It was found that when the emitter surface had less than a monolayer coverage of alkali metal, it was the atomically closest packed plane of the emitter that yielded the highest thermionic emission density. The effects of surface contaminants were studied and evidence was obtained suggesting that the high work function of the 112 plane of tungsten and molybdenum may be caused by a contaminant. (auth)

12795 APPARATUS FOR PRODUCING A HIGH INTENSITY ELECTRON STREAM USED TO EXCITE CHARACTERISTIC RADIATION OF ELEMENTS. Robert E. Fearon (to Well Completions, Inc.). U. S. Patent 3,120,610. Feb. 4, 1964. Filed May 15, 1961.

An apparatus used to analyze known elements in a sub-

stance in a vacuum is discussed. The production of electrons of a specific energy is described. A static generator is used to produce the electrons, and a cathode discharge tube is used to accelerate the electrons. A scatter is provided at the end of the device to breakup the beam into streams, and a variable magnetic field directs the electrons of selected energy to the element to be analyzed. The characteristic x rays from the element may then be detected and measured by appropriate means. (R.E.U.)

12796 METHOD FOR CONVERSION OF CESIUM ALUM TO RADIATION SOURCE MATERIAL. R. E. Lewis (to U. S. Atomic Energy Commission). U. S. Patent 3,124,538. Mar. 10, 1964.

A method of recovering radioactive cesium values and incorporating them in a glass radiation source is described. Cesium alum, the usual cesium-137 source material obtained from fission-product waste solutions, is reacted with oxalic acid in aqueous solution. The cesium is then crystallized as cesium tetraoxalate, which is heated to 170 to 240°C to produce a substance, primarily cesium acid oxalate, suitable for formation of glass. The cesium acid oxalate is combined with other glass-forming materials such as silica, cadmium oxide, and lithium carbonate, and the mixture is heated to the melting point and cooled to produce glass. High-activity sources with favorable physical properties are produced in a simple procedure amenable to remote operation behind heavy shielding. (AEC)

Accelerators

Refer also to abstract 12900.

12797 (AD-412320) A PULSED RAPID FILM-ADVANCE CAMERA. Technical Report No. 13. D. E. Damouth and O. E. Haas (Michigan. Univ., Ann Arbor. Coll. of Literature, Science, and the Arts). July 1963. Contract Nonr-1224(23). 15p. (ORA-03106-13-T)

A camera was developed which will, after the occurrence of an event in a proton accelerator, advance one frame of film in a very short time, then wait for the next event which may occur after some random time interval. This cycle must then be repeated up to seven times. The camera will advance a double frame (eight sprocket holes, which is approximately 1.5 in.) in less than 30 msec, thus allowing an increase of up to a factor of ten in the rate of data accumulation over conventional equipment which obtains one picture per accelerator pulse. (auth)

12798 (CEAL-1008) DESIGN OF A 6-Bev FARADAY CUP. Paul H. Burr (Massachusetts Inst. of Tech., Cambridge and Cambridge Electron Accelerator, Mass.). Jan. 2, 1964. Contract AT(30-1)-2076. 19p.

This report describes a Faraday cup for use as a direct beam monitor and beam stopper for the 6-Bev external electron beam of the electron accelerator. Design criteria for an instrument capable of 0.1% absolute accuracy are presented. (auth)

12799 (CERN-63-35) THE HIGH-INTENSITY MUON BEAM WITH LOW PION CONTAMINATION AT THE CERN SYNCHRO-CYCLOTRON. A. Citron, M. Morpurgo, and H. Oeveras (European Organization for Nuclear Research, Geneva). Nov. 27, 1963. 123p.

Theory for designing a muon beam of high intensity and purity is presented. The short lens approximation is treated. Comparison with experimental results and recent computations indicates that this approximation must be checked by more elaborate calculations. The matching of the channel to the accelerator is also treated, and the analyzing magnet is described. Experimental observations on the performance of the CERN channel are presented and examined in relation to the theory. (D.C.W.)

12800 (CERN-63-37(p.83-95)) FAST BEAM EXTRACTION AND THE EXTERNAL PROTON BEAM. B. Kuiper and G. Plass (European Organization for Nuclear Research, Geneva).

A survey of the techniques used in the extraction of the CERN proton synchrotron beam and its transport to the target is presented. (C.E.S.)

12801 (JINR-P-1480) K RASCHETU ELEKTRICHESKOI SISTEMY VYVODA LOUNOGO PUCHKA V KLASSICHESKOM TSIKLOTRONE. (On a Calculation of an Electric Deflector for the Ion Beam Extraction in a Classical Cyclotron). V. V. Babikov, G. N. Vyalov, and G. Indreas (Indreash) (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Reactions). 1963. 16p.

Two methods for describing the ion motion in a deflector are considered. They are equally applicable both for electrostatic and r-f beam extraction systems. Using these methods, a rather detailed analysis of electrostatic and r-f deflectors for 120 and 150 cm cyclotrons was made. (auth)

12802 (ORNL-3444) PHASE MOTION OF IONS IN ISOCHRONOUS CYCLOTRONS. F. M. Russell (Oak Ridge National Lab., Tenn.). Jan. 1963. Contract W-7405-eng-26. 33p.

The motion in phase of ions in isochronous cyclotrons possessing non-radial accelerating gaps is examined, and it is shown that under certain conditions a quasi-phase-stable state is possible. By differentially modulating the gap voltage with radius in adjacent gaps and slightly perturbing the magnetic field it is possible to focus ions upon a chosen phase angle. The major advantages associated with such a scheme are the reductions in sensitivity of the phase of ions to errors in the magnetic field and to gap voltage variations. The possibility of controlling the phase of ions by using extra electrodes also is examined; it is shown that large phase compression could be achieved under certain conditions. (auth)

12803 (TID-7685) ARGONNE ACCELERATOR USERS GROUP MEETING HELD AT ARGONNE NATIONAL LABORATORY, MAY 10-11, 1963. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 48p.

Information on the status of the accelerator and experimental facilities, the experimental program, and users' arrangements and procedures is presented. The apparatus and procedures for measuring and analyzing bubble chamber data are also described. Additionally, the design and performance of a polarized proton target are discussed, and preliminary results on elastic π^+-p interactions are presented. (D.C.W.)

12804 (TID-7686) ARGONNE ACCELERATOR USERS GROUP MEETING HELD AT ARGONNE NATIONAL LABORATORY, DECEMBER 8-9, 1961. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 129p.

Separate abstracts were prepared for the thirteen papers included. (D.C.W.)

For abstracts of individual papers see: 12805, 12806, 12807, 12808, 12809, 12810, 12811, 12812, 12813, 12912, 12913, 12914, and 12915.

12805 (TID-7686(p.3-7)) GENERAL ASPECTS OF THE HIGH-ENERGY PHYSICS PROGRAM. R. H. Hildebrand (Argonne National Lab., Ill.).

The progress at the zero gradient synchrotron and new facilities is indicated, and budgetary restrictions and

their effect on bubble chamber construction and beam provision are described. Plans for data analysis are also indicated. (D.C.W.)

12806 (TID-7686(p.9-12)) CONSTRUCTION PROGRESS AND SCHEDULE. A. V. Crewe (Argonne National Lab., Ill.).

The progress on the accelerator, particularly magnet construction, is discussed. Difficulties in providing engineering support to users are also indicated. (D.C.W.)

12807 (TID-7686(p.13-17)) REPORT FROM THE ELECTRONICS ADVISORY COMMITTEE. Lou Koester (Illinois. Univ., Urbana).

Some recommendations on beam magnets are summarized, together with action and decision on various electronic equipment. (D.C.W.)

12808 (TID-7686(p.19-23)) POLARIZED HIGH-ENERGY PROTON BEAMS. D. Cohen (Argonne National Lab., Ill.).

Some uses for a 12.5-Bev beam are listed, and some schemes for obtaining such a beam from the ZGS are discussed. A method is proposed for avoiding depolarizing resonances in the synchrotron, which were revealed by a computer analysis of orbits in the accelerator. (D.C.W.)

12809 (TID-7686(p.25-33)) EXTERNAL PROTON BEAMS FROM ZGS. L. C. Teng (Argonne National Lab., Ill.).

The three systems considered for proton extraction from the synchrotron are discussed. The results of some preliminary calculations on the properties of the extracted beams are included. (D.C.W.)

12810 (TID-7686(p.43-56)) ELEMENTS OF MESON AND PROTON BEAM SYSTEMS. L. Ratner (Argonne National Lab., Ill.).

The components and properties of the systems are described. Some projected beam characteristics are included. (D.C.W.)

12811 (TID-7686(p.57-8)) SEPARATED BEAMS, 3-6 Bev/c. U. E. Kruse (Illinois. Univ., Urbana).

A proposed design for a 6 Bev/c separated K^- beam is discussed. (D.C.W.)

12812 (TID-7686(p.59-62)) LOW-ENERGY SEPARATED BEAMS (17°–30°). D. I. Meyer (Michigan. Univ., Ann Arbor).

The usefulness of the 30 and 17° beams of the zero-gradient synchrotron (ZGS) is discussed. Estimates indicate that for negative particles with momenta <6 Bev/c the ZGS will be competitive in intensity with the Brookhaven Alternating Gradient Synchrotron. (D.C.W.)

12813 (TID-7686(p.63-8)) ABERRATIONS AND OTHER PROBLEMS IN PRODUCING SEPARATED BEAMS. M. L. Good (Wisconsin. Univ., Madison).

Tolerances for the bending magnets, quadrupoles, and separators are discussed, together with design to meet the tolerances. The usefulness of separators designed for high-energy separated beams for other separator uses is considered. (D.C.W.)

12814 INVESTIGATION OF AN HF ION SOURCE. J. Gueldenpenning and M. Richter (Kernphysikalisches Institut der Deutschen Akademie der Wissenschaften, Berlin). Ann. Physik (7), 12: 113-20(Oct. 1963). (In German)

Measurements on a high-frequency ion source, which will be installed in a 4-Mv pressure-tank Van de Graaff Accelerator, are described. From the measurements it was recognized that the extracted ion current of the high-frequency output of the source depends on the pressure in the discharge vessel and on the height of the discharge space of the cathode limited by the quartz ring. For the used source output the extracted ion current had no optimum. The degree of self-focusing depended essentially on the pressure and source output. For a source frequence of 41 MHz and a high-frequency output of 150 w the most favorable gas pressure in the discharge vessel was 28 to 30 mTorr. The geometry of the extraction system for the used arrangement is most advantageous when the height of the quartz ring is chosen as the same as the external diameter of the nozzle. A comparison of the ion current with and without condensor before the 5-step lens chain showed it to have a favorable influence when the utilized ion current was increased. (tr-auth)

12815 MEASUREMENT OF THE CROSS SECTION OF A BEAM WITHOUT ITS DESTRUCTION IN AN ACCELERATOR CHAMBER. I. P. Karabekov. At. Energ. (USSR), 15: 467-72(Dec. 1963). (In Russian)

In self-controlled accelerators the beam characteristics are used to feed back the information needed for correcting the magnetic and the accelerating systems; this technique allows the upper energy limits to be increased. In order to supply the required information, the cross section of the beam was measured without interfering with it. The field potential of a particulate beam may be derived from a correlation involving the potential created by the beam at a given point and from the function defining the dependence of the potential on the distance between that point and the electric axis of the beam and on the cross section of the beam, together with the radial distribution of the particles. The number of the particles was found to decrease suddenly at the boundary region. It was estimated that about 95% of the particles are contained within the measured cross section. (TTT)

12816 STARTUP OF THE MODEL OF THE ALTERNATING-ENERGY CYCLOTRON. A. G. Alekseev. At. Energ. (USSR), 15: 537(Dec. 1963). (In Russian)

On September 25, 1963, the variable-energy isochronous-sector cyclotron was placed in service at the D. V. Efremov Scientific Research Institute for Electro-physical Equipment of the USSR State Commission for the Application of Atomic Energy. A 4-Mev, molecular H ion beam was obtained. (TTT)

12817 SOME DOSIMETRY PROBLEMS OF THE ALTERNATING GRADIENT SYNCHROTRON (AGS). Frederick P. Cowan, Leigh F. Phillips, and Robert J. King (Brookhaven National Lab., Upton, N. Y.). Health Phys., 10: 33-40(Feb. 1964).

After a discussion of methods of high-energy dosimetry, data on linear energy transfer, and quality factors of pions, protons, deuterons, and alpha particles in water are summarized. These are shown to approximate the values for tissue and are given both for specific particle energies and as averages for complete tracks. The dosimetry of μ-meson fluxes is considered from a theoretical point of view. The response of personnel monitoring equipment to such fluxes is shown to be fail-safe for average particle quality factors of 2.9 or less. External proton beams are shown to be extremely hazardous and some data are given on the response of film badges to beams of protons and pions. Typical depth-dose curves are given. They show substantial build-up only in relatively uncontaminated beams of high-energy particles. Activation of machine parts and targets is described briefly. (auth)

12818 VELOCITY DISTRIBUTION IN ELECTRON STREAMS. (PARTS I-III). Long Fei Chang. Thesis, Syracuse, N. Y., Syracuse Univ., 1962. 92p.

The velocity distribution patterns of electrons accelerated by given electrostatic fields, assuming the initial velocity distribution to be Maxwellian, is discussed for finite plane diodes and a diode of hyperbolic electrodes. To determine the stability of the beam produced by the hyperbolic electrodes, space charge waves for a double-peaked velocity distribution are examined. The concept of electron density in a 6-dimensional phase space is adopted; Liouville's theorem is used to determine the electron density in the phase space. The velocity regions to be integrated to give the electron and current densities are determined from the electron trajectories. Analytical results of current and electron densities are obtained for a semi-finite emitter, a rectangular emitter, and a circular emitter in an infinite plane diode. The method of determining the region of allowable velocity in the interelectrode space is discussed for the case of hyperbolic electrodes, and a simple method is devised to determine the shape and number of regions of allowable velocities along the axis of symmetry. No growing space charge waves are found in the electron beam formed by a pair of symmetrically located emitters in the hyperbolic electrode system, when the transverse velocity is approximated by a double-peaked Cauchy distribution, and hence one concludes that the electron beam is stable. Instability in the beam is found when the transverse velocity distribution is approximated by a double rectangular distribution. The instability problem can be resolved only by experiment, unless a better model for the velocity distribution is used. The velocity distribution actually obtained was not tractable for the perturbation analysis. (M.P.G.)

12819 ION SOURCE FOR POSITIVE ION ACCELERATORS. Norman B. Brooks and Bertram S. Quintal (to High Voltage Engineering Corp.). U. S. Patent 3,121,816. Feb. 18, 1964. Filed Sept. 22, 1960.

A duoplasmatron-type ion source is described that comprises, in combination, a cathode adapted to emit electrons upon electron bombardment, an apertured magnetic pole-face lens, and an apertured extraction electrode in axial alignment. A thermionic filament is provided near the axis of this combination, and a potential difference is provided to prevent the electrons from "backing up" on the filament. The electrons are caught in a magnetic mirror and produce ions in the source gas, the extraction electrode then draws them out and the electrons return to strike the cathode causing emission of electrons. The sintered cathode then acts as the principal source of electrons. (R.E.U.)

12820 SERVICING MECHANISM FOR GAS-COOLED NUCLEAR REACTORS. Alfred Edward Clauson (to General Electric Co. Ltd.). U. S. Patent 3,122,485. Feb. 25, 1964. Priority date Dec. 8, 1959, Great Britain.

A servicing mechanism is described that includes a rotatable charge tube with an articulated radial end portion adapted to engage the ends of the fuel channels within the pressure vessel of the gas-cooled reactor. A cam defines a plurality of radial positions for the end portion, and an indexing member carried by the cam is provided to cooperate with sensing means within the pressure vessel to operate the cam in accordance with the azimuthal position of the end portion with respect to the core channels. (R.E.U.)

12821 ENLARGEMENT OF CHARGED PARTICLE BEAMS. Sherman R. Farrell (to High Voltage Engineering Corp.). U. S. Patent 3,120,609. Feb. 4, 1964. Filed May 4, 1961.

A method and apparatus are described for elongating the geometric cross section of a beam along two mutually perpendicular axes. Elongation is affected by deflection of the particles in a hyperbolic field. (R.E.U.)

Astrophysics and Cosmology

12822 NEUTRAL HYDROGEN IN GALACTIC STAR CLUSTERS. I. A SEARCH FOR NEUTRAL AND IONIZED HYDROGEN IN FIVE GALACTIC CLUSTERS. R. D. Davies and H. M. Tovmassian (Univ. of Manchester, Eng. and Bjurakan Astrophysical Observatory, Erivan). Monthly Notices Roy. Astron. Soc., 127: 45-59(1963).

The 21-cm line emission from neutral hydrogen was investigated at the position of the following galactic clusters: the Pleiades, NGC 1502, the Trapezium–Orion cluster, NGC 2244, and NGC 6910. The measurements were made using a six-channel receiver with a parametric amplifier first stage in conjunction with the 250 ft radio telescope. Neutral hydrogen was found at the position of all the clusters except NGC 1502. Arguments are presented that indicate that it is doubtful whether the neutral hydrogen now at the position of the older Pleiades cluster is the remainder of the same mass of gas from which the stars were formed. A variation of 50:1 was found in the ratio of gaseous to stellar mass in the four O-type clusters; the results indicate that the more massive clusters retain a greater proportion of their gas. The neutral hydrogen in the Trapezium–Orion cluster, NGC 2244, and NGC 6910 was found in expanding shells surrounding the ionized hydrogen regions associated with the cluster stars. The recession velocities were similar to those of the clusters and the expansion velocities of the first two are similar to those found optically in the ionized hydrogen regions. (auth)

12823 NEUTRAL HYDROGEN IN GALACTIC STAR CLUSTERS. II. THE RELATION BETWEEN NEUTRAL AND IONIZED HYDROGEN IN A SECTION THROUGH CYGNUS X. R. D. Davies and H. M. Tovmassian (Univ. of Manchester, Eng. and Bjurakan Astrophysical Observatory, Erivan). Monthly Notices Roy. Astron. Soc., 127: 61-70(1963).

The neutral and ionized hydrogen distribution in a strip across the predominately thermal radio source Cygnus X was investigated in detail. The thermal emission was separated into eight centers having angular diameters when corrected for beam broadening of 11 to 40′ and emission measures in the range 500 to 10,300 cm^{-6} pc. Excess neutral hydrogen emission was found surrounding four of these centers; in two cases the neutral hydrogen distribution was sufficiently resolved in angle to indicate that it was in the form of a shell expanding at 4.2 km/s in one and 12.5 km/s in the other. The neutral and ionized gas masses considered to be most likely associated with a cluster centered at $\alpha = 20^h\ 28.4^m$ in the VI Cygnus association were 360 and 330 solar masses respectively. (auth)

12824 GAMMA RAY ASTRONOMY. William L. Kraushaar and George W. Clark (Massachusetts Inst. of Tech., Cambridge). Sci. Am., 206: 52-61(May 1962).

Information gained by γ records obtained by the so-called γ telescope orbited by the Explorer XI satellite, launched on April 27, 1961, is described. The γ rays have energies above 50 Mev, and are created, for the most part, when high-energy particles collide with other particles,

the most important source of high-energy γ rays being the process that occurs when a high-energy proton strikes either another proton or an atomic nucleus and produces neutral pi mesons. The construction of such a telescope is described and illustrated. A central counter and the Cherenkov counter make up the telescope in the sense that when a charged particle traverses the instrument from the forward direction, the two counters respond simultaneously. If the cause is an incident charged particle, a veto counter also responds and wipes out the record of the simultaneous event. But if the incident particle is a γ ray, the veto counter does not respond, and a signal is telemetered to earth giving an indication of the energy lost by the electron-positron pair that activated the central scintillator. Performance of the telescope and its space vehicle is discussed, as well as problems encountered in collecting and interpreting the data. The 23 days of data so far analyzed include a total of 9 hr during which the telescope was pointing into space and another 10 hr pointing at the earth. During the 9 hr of looking at space the detectors recorded 22 events as being due to γ rays and about 22000 as being due to charged cosmic rays; during the 10 hr of looking at the earth the records show 105 γ rays and about 3000 charged particles. Functioning of counters and validity of the data are evaluated, and it was concluded that Explorer XI has really detected γ rays from space. Since it detected 22 in 9 hr of total observation time, the rate is 2.4 per hr. The intensity of γ rays that should arrive at the earth from various regions is computed by making certain assumptions about gas and cosmic ray densities. A map is provided showing the direction of origin of 22 γ rays studied so far. (BBB)

12825 ANALYSIS OF THE DECAMETER-WAVELENGTH RADIO EMISSION FROM THE PLANET JUPITER. Norman Frank Six, Jr. Thesis, Gainesville, Fla., Univ. of Florida, 1963. 298p.

An analysis of data collected during the 1961 observing season at radio observatories in Florida and Chile has confirmed and strengthened previous conclusions regarding the Jovian decameter emission, while providing a better understanding of the source distribution at various frequencies and the role played by solar particles. The data from different stations and different years were merged using an IBM 709 computer to produce probability histograms for frequencies in the range from 10 to 31 Mc. The histograms show the 3 principal decameter sources localized in Jovian longitude System III, which rotates with a period of 9 hr, 55 min, 29 sec. The secondary source appears broadened and is bifurcated on several of the histograms, suggesting the possible existence of 2 closely spaced sources. The tertiary source almost disappears at frequencies above 18 Mc. The general increase in observed Jupiter activity with the elongation of the planet is quite evident. It is concluded that the decrease in Jupiter activity around opposition may be caused by the deflection of solar plasma by the Earth's magnetosphere, i.e., that solar plasma plays a fundamental role in the decameter emission process. The 1961 data confirm the long-term inverse correlation of Jovian decameter activity with the sunspot cycle. A synopsis of the experimental data pertaining to the decimeter and decameter emission, including the 1961 results, is presented, followed by a discussion of the theories of origin of the non-thermal radiation from Jupiter. The close approach of Comet Seki 1961 f was monitored in an effort to detect decameter emission. Results were inconclusive. (M.P.G.)

12826 CHARGED PARTICLE INDUCED HEATING OF A GASEOUS NEBULA. Gerald Thomas Davidson. Thesis, Madison, Wis., Univ. of Wisconsin, 1963. 138p.

The possibility of heating a small nebula by injection of protons with energies of 10 kev to 10 Mev is investigated. Transfer of energy to the gas is primarily by collisions of protons with free and bound electrons. A slowing formula giving the energy loss per unit path length is used to find the rate at which energy is transferred to the gas. In equilibrium the rate of energy gain is equated to the rate of energy dissipation to obtain the electron temperature. Ionization equilibrium equations are established for H and other less abundant elements, ionization being by collisions of protons with atoms and, at high temperatures, by collisions of thermal electrons with atoms. The slowing equation, along with ionization and temperature equations, is integrated for protons emitted from a point source. For certain intensities of the source it is found that the nebula is considerably more ionized than a gas of the same temperature where ionization is chiefly by thermal electrons. The transfer of Lyman-α radiation resulting from H recombinations is investigated. Lyman-line radiation is found to be quite ineffective in heating any part of the nebula. (Dissertation Abstr.)

12827 FIZIKA SOLNECHNOI KORONY. (Physics of Solar Corona). I. S. Shklovskii. Moscow, Publishing House of Literature of Physics and Mathematics, 1962. 516p.

A review is given of physical conditions in the corona, chromosphere, and intermediate solar sphere. Photometric studies of solar corona, the nature of corona radiation and absorption spectra, quantitative chemical analysis, and ionization problems are discussed. Ultraviolet solar radiation and its atmospheric effects, sporadic solar radio emissions, and solar corona and interplanetary gas theory are also considered. (274 references) (R.V.J.)

Atomic Physics

12828 (RTD-TDR-63-4177) NEW METHOD OF MEASURING TRANSITION PROBABILITIES. F. Karstensen and J. Richter (Kiel. Universitat). Nov. 7, 1963. Contract AF-EOAR-62-114. 31p.

A combination of intensity and lifetime measurement methods for obtaining atomic transition probabilities is described. Lifetime measurement methods are discussed, and two experimental arrangements are described. Results of the initial measurements are given. (auth)

12829 (TID-20169) IONIZATION AND CHARGE TRANSFER CROSS SECTIONS. Technical Status Report No. 16. Progress Report, March 1, 1963–November 30, 1963. D. W. Martin, D. S. Harmer, and L. J. Puckett (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Dec. 1, 1963. Contract AT(40-1)-2591. 15p.

The apparent ionization cross sections for He^{2+} incident on He and H_2 were measured for incident energies of 0.50 to 1.00 Mev. The results agree quite well with Born approximation calculations. The cross sections for He^{2+} point-charge ions were also calculated in good agreement with the experimental results, using Bethe's treatment of high-energy ionization. The He^{2+} results show the observed cross section to be the ion charge squared times the cross section for protons or electrons of the same velocity incident on the same target gas. Excellent agreement was also obtained between the He^{+} data for molecular hydrogen and a more exact theoretical treatment of He^{+} on

atomic hydrogen. Initial measurements of He^{2+} beams in Ar and N_2 showed these cross sections to be several times larger than those for H_2 and He. Failure of a gas pressure gage, however, affected the data. An arrangement for measurements with incident neutral beams was constructed, and an e/m analyzer for slow positive ions produced by fast particles was considered. (D.C.W.)

12830 ELECTRON RADIATIVE TRANSITIONS IN A COULOMB FIELD. W. J. Karzas and R. Latter (RAND Corp., Santa Monica, Calif.). Astrophys. J., Suppl. Ser., 6: No. 55, 167-212(May 1961).

Free-free, bound-free, and bound-bound Gaunt factors and oscillator strengths were computed for electrons in a pure Coulomb potential. Numerical results are presented for a wide range of electron and photon energies. In addition, for the free-free case, average Gaunt factors and the rate of bremsstrahlung production were obtained as functions of temperature for a Boltzmann distribution of electron energies. (auth)

12831 HIGH-DENSITY EQUATION OF STATE FOR HARD PARALLEL SQUARES AND CUBES. William G. Hoover (Univ. of California, Liverman). J. Chem. Phys., 40: 937-8(Feb. 15, 1964). (UCRL-7531-T)

High-density systems of hard parallel squares and cubes enclosed in rigid containers are considered. Evaluation of the exact volume-dependence of the configurational integral shows that such systems obey the free-volume equation of state. Low order deviations from the free-volume theory, found by Salsburg and Wood in an analogous calculation for hard circles and spheres, are not found for squares and cubes. (auth)

12832 FIFTH AND SIXTH VIRIAL COEFFICIENTS FOR HARD SPHERES AND HARD DISKS. Francis H. Ree and William G. Hoover (Univ. of California, Livermore). J. Chem. Phys., 40: 939-50(Feb. 15, 1964). (UCRL-7372)

New expressions for the fourth, fifth, and sixth virial coefficients were obtained as sums of modified star integrals. The modified stars contain both Mayer f functions and $\bar{f}$ functions ($\bar{f} \equiv f + 1$). It is shown that the number of topologically distinguishable graphs occurring in the new expressions is about half the number required in previous expressions. This reduction in the number of integrals makes numerical calculation of virial coefficients simpler and more nearly accurate. For particles interacting with a hard-core potential, values of the modified star integrals are shown to depend strongly on dimension; for example, several modified star integrals are identically zero for hard disks (two dimensions), but give nonzero values for hard spheres (three dimensions). Of all the modified star integrals contributing to the fourth, fifth, and sixth virial coefficients, the complete star integrals are shown to be the largest. Mayer's expressions for these coefficients made the complete star integrals the smallest contributing integrals. The fifth (B_5) and sixth (B_6) virial coefficients of hard-sphere and hard-disk systems are obtained by Monte Carlo integration of the modified star integrals. The resulting values are spheres: $B_5/b^4 = 0.1103 \pm 0.0003$; $B_6/b^5 = 0.0386 \pm 0.0004$ and disks: $B_5/b^4 = 0.3338 \pm 0.0005$; $B_6/b^5 = 0.1992 \pm 0.0008$ where b is the second coefficient. Estimated values of B_7 obtained from a Padé approximation to $PV^2/(N^2kT) - V/N$ are $B_7/b^6 = 0.0127$ for hard spheres and 0.115 for hard disks. For hard spheres virial series calculations including terms through the sixth virial coefficient give values of PV/(NkT). Furthermore the approximate Padé expression agrees within 2% with the molecular dynamics data for all densities on the fluid side of the solid-fluid transition. This agreement indicates convergence of the virial series along the entire fluid branch of the hard-sphere equation of state. (auth)

12833 CELL MODEL FOR QUANTUM FLUIDS. [PART] I. Douglas Henderson and Robert D. Reed (Arizona State Univ., Tempe). J. Chem. Phys., 40: 975-8 (Feb. 15, 1964).

The cell model of Lennard-Jones and Devonshire is modified to include quantum effects. The energy levels are calculated by means of the WKB method with the effects of the first three shells of neighbors taken into account. The thermodynamic properties of hydrogen, deuterium, and tritium are calculated for the reduced volume $v^* = \frac{5}{3}$. (auth)

12834 THE RELATION BETWEEN THE CROSS SECTIONS FOR ELASTIC AND INELASTIC SCATTERING IN NONADIABATIC ATOMIC COLLISIONS. M. A. Kozhushner and Yu. S. Sayasov. Opt. Spectry. (USSR) (English Transl.), 15: 313-15(Nov. 1963).

A relation is found between the elastic and inelastic cross sections for collisions of atomic systems in which the inelastic process (electron transition) is determined by the intersection (or "pseudointersection") of terms. It is shown that the total cross section for scattering is $\sigma_t = \sigma_p$, where σ_p is the cross section for potential scattering in the ground state term corrected for interaction. Detailed expressions are found for the properties of elastic cross sections near the threshold of an inelastic process for various types of terms and the interactions between them. (auth)

12835 PHOTOIONIZATION OF ATOMS AND RECOMBINATION OF IONS IN THE VAPORS OF ALKALI METALS. Yu. V. Moskvin. Opt. Spectry. (USSR) (English Transl.), 15: 316-18(Nov. 1963).

The results of calculations of photoionization absorption from excited states of atoms and radiative recombination of ions of alkali metals are presented and discussed. The recombination cross section of the 6p level of the cesium atom is compared with the experimental value and with a value calculated in terms of proton recombination. (auth)

12836 PRODUCTION OF FAST MOLECULAR BEAMS USING GASEOUS MIXTURES. R. Klingelhoefer and P. Lohse (Technische Hochschule, Karlsruhe, Ger.). Phys. Fluids, 7: 379-81(Mar. 1964).

According to Becker and Henkes, relatively fast molecular beams of heavy gases can be produced by having a mixture of the heavy gas and a light acceleration gas expand out of a nozzle and transferring the core of the nozzle flow into high vacuum. By mass spectrometric analysis of the collected beam, the degree of enrichment of the heavy gas is investigated for different argon–hydrogen mixtures and for different inlet pressures. The particle flow density of the molecular beam is obtained by measurement of the pressure head. The acceleration of argon is investigated by a time-of-flight method. For an initial mixture of 1% Ar and 99% H_2, the system yields a maximum of 40% for the argon mole fraction in the beam at an inlet pressure of 2 atm. The corresponding flow density is 1.3×10^{17} Ar atoms per cm^2 per sec at a distance of 60 mm from the nozzle; the beam velocity is 2100 m/sec corresponding to a kinetic energy of the argon atoms of about 1 ev. (auth)

12837 COLLISIONLESS EXPANSION OF GAS CLOUDS IN THE PRESENCE OF AN AMBIENT GAS. George Bienkowski (Astrophysics Research Corp., Los Angeles). Phys. Fluids, 7: 382-90(Mar. 1964).

The collisionless expansions of spherical and cylindrical gas clouds into an ambient gas are investigated. General

expressions for the higher moments are derived and evaluated. The solutions exhibit effects not apparent in previous work on collisionless expansions bounded by vacuum. Mass flow, temperature, and velocity exhibit propagating maxima that decay in amplitude and diffuse with time. Time constants for the duration of the expansions are obtained as a rough criterion for possibility of shock formation. Comparisons are made with the Euler solution and a short time collisional solution obtained by numerical integration of the Boltzmann equation with a model collision term. (auth)

12838 SECOND-ORDER HYPERFINE STRUCTURE IN HYDROGENIC ATOMS. D. A. Hockensmith (Battelle Memorial Inst., Columbus, Ohio) and L. L. Foldy. Phys. Rev., 133: A1514-24(Mar. 16, 1964).

A calculation of the hyperfine splittings in the 1s and 2s levels of hydrogenic atoms is made. Second-order terms in the nuclear magnetic dipole moment and terms of comparable magnitude arising from nuclear structure effects are calculated. Also included is a term derived by the use of uncrossed and crossed photon diagrams; this term is necessary because the one-electron Dirac Hamiltonian, which is used, evidently does not properly take certain quantum electrodynamic effects into account. In order to compare with experiment, the ratio of the hyperfine splitting in the 2s state to the splitting in the 1s state is taken and evaluated for the case of the hydrogen atom; this result is combined with a previous result and the final theoretical value of $\frac{1}{8}$ (1.00003445 ± 0.00000002) is in agreement with the experimental value of $\frac{1}{8}$ (1.000034495 ± 0.000000060). Complete agreement has not yet been reached with respect to the splittings themselves. The calculation consists in solving the separated radial equations arising from the Dirac Hamiltonian in which the nuclear magnetic moment and the finite size of the nucleus are considered as perturbations. An iteration scheme is devised that uses certain properties of the unperturbed solution. (auth)

12839 CROSS SECTIONS FOR SOME N_2^+ AND NII EMISSIONS EXCITED BY 1- TO 10-kev N_2^+ ON N_2. John P. Doering (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 133: A1537-45(Mar. 16, 1964). (LADC-5935)

Emission cross sections for the (0,0), (0,1), and (1,2) N_2^+ first negative bands and the NII $3p^5D-3d^5F^0$ lines were measured in the excitation of N_2 by a beam of 1- to 10-kev N_2^+. Light produced along a 15-cm path was integrated and analyzed with a monochromator. A 180-ev electron beam was used for calibration with the aid of the known electron + N_2 cross section for N_2^+ (0,0) first negative band excitation. The light output per incident particle was measured as a function of N_2 gas pressure from 0.1 to 20 microns at each energy. Cross sections were calculated on the basis of a mechanism that predicted the observed pressure variation of light output. The N_2^+ first negative system emission cross sections were found to reach a broad maximum near 7 kev while that for NII increased throughout the energy range studied. Doppler shift experiments showed that most of the N_2^+ emission observed was the result of charge exchange processes. The NII emissions appear to be excited by violent ionizing collisions. The maximum value of the N_2^+ first negative band (0,0) emission cross section was found to be 1.2×10^{-17} cm^2. (auth)

12840 METHOD AND APPARATUS FOR PRODUCING AND MEASURING THE ALIGNMENT OF METASTABLE HELIUM ATOMS. Peter A. Franken. U. S. Patent 3,122,702. Feb. 25, 1964. Filed Oct. 7, 1958.

The method described is used to align helium atoms in the metastable 2^3S_1 state by subjecting them to unpolarized resonance radiation from a helium arc. The method is used to determine an ambient magnetic field in which the aligned atoms are situated. (R.E.U.)

Cosmic Radiation

12841 (AFCRL-63-681) COSMIC-RAY INTENSITY VARIATIONS DURING 1962. Technical Note No. 1. A. E. Sandstroem, E. Dyring, L. Ekstroem, B. O. Groenkvist, S. Lindgren, and B. Oestman (Uppsala Univ. Inst. of Physics). Apr. 25, 1963. Contract AF61(052)-614. 26p. (AD-413088)

A detailed account is given of the diurnal and semi-diurnal variation recorded in Uppsala and Kiruna by a neutron monitor, two cubical telescopes and six inclined telescopes. Six decreases that took place are illustrated by bi-hourly diagrams. The diurnal variation is illustrated by a number of vector sum diagrams for sun rotation periods. For the diurnal variation recorded by part of our instruments a rather abrupt phase shift to later hours seems to have occurred in the autumn. (auth)

12842 (NP-tr-1090) ON THE ASSOCIATION OF THE VARIATION OF COSMIC RAYS IN HIGH LATITUDES WITH SOLAR ACTIVITY AND GEOMAGNETIC DISTURBANCES. A. I. Ol'. Translated for Boeing Scientific Research Labs., Seattle, Wash., from Tr. Arktichesk. i Antarktichesk. Nauch.-Issled. Inst., Leningrad, 223: 110-49(1960). 74p.

The relation of variations in the intensity of cosmic radiation to solar activity and geomagnetic disturbances was studied. Observations at high latitudes of the meson intensity of cosmic radiation were investigated, using data from middle latitude observatories for comparison. (D.C.W.)

12843 CHARACTER OF LUNAR DIURNAL VARIATIONS OF COSMIC RAYS. L. I. Dorman. Sb. Statei, Mezhduved. Geofiz. Kom. Kosmich. Luchi, No. 4, 253-5 (1961).

The existence of a period of lunar variations of cosmic rays, coinciding with the period of lunar diurnal culminations, is difficult to prove experimentally, as the lunar shadow is too narrow to permit detection of its influence. Two possibilities for pseudolunar diurnal variations of cosmic rays arise. The first is related to the amplitude modulation of solar diurnal variations in the 27-day period. Mathematical analysis of amplitudinal modulation yields two periods, 23.2 and 24.9 hr, the latter coinciding with the lunar 24-hr period. The second possibility is related to phase modulation. Mathematical analysis in this case yields two periods identical to those determined in the first case. Experimental proof of the existence of the 23.2-hr period would establish the falsity of lunar diurnal variations. If experimental investigations do not indicate the existence of such a period, the reality of lunar diurnal variations would be established. Such variations can be explained as the result of a tidal wave in interplanetary plasma with frozen magnetic force lines. Such a wave causes periodic changes in the geomagnetic threshold that acts on earth as the lunar diurnal variations. (OTS)

12844 THE NUCLEAR-ACTIVE AND MUON COMPONENTS IN EXTENSIVE AIR SHOWERS. John Franklin Gaebler. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1963. 125p.

Features of the nuclear-active and muon components in extensive air showers were studied with the use of a multiplate cloud chamber. The chamber was operated in association with an ion chamber and scintillator array, at a

depth of 1000 g/cm^2 in the atmosphere. A total of 59 nuclear events were detected in which the energy, E_γ^0, of the π^0 secondaries exceeded one Bev. Multiple penetrating particle (M.P.P.) events were also seen. The shape of the integral spectrum of π^0-produced EM cascades was found to be $d \log N(\geq E_\gamma^0)/d(\log E_\gamma^0) = -\gamma$, where $\gamma = 0.9 \pm 0.2$ for $10 \leq E_\gamma^0 \leq 100$ Bev, and $\gamma = 0.5 \pm 0.2$ for $1 \leq E_\gamma^0 < 10$ Bev. The ratio of the number of charged to the number of neutral particles responsible for events in which $E_\gamma^0 \geq 1$ Bev is $2.4 \pm 0.6:1$, with an even higher ratio in the energy intervals $E_\gamma^0 \geq 10$ Bev and $1 \leq E_\gamma^0 < 2$ Bev. A large fraction of the particles observed must therefore be pions, particularly in the 2 to 10 Bev region. The shape and particle composition of the spectrum at energies of $2 \leq E_\gamma^0 \leq 10$ Bev favors a high elasticity in (π^+, Pb) interactions. About 10% of the energy of the interactions appears to be expended in π^0 production. Two MPP events of local muon density $\geq 30/m^2$ were seen, of which one appears to represent a muon "beam" of the type described by Vernov. An attenuation length for individual EAS of $\lambda_a = 174^{+34}_{-34}$ g/cm^2 is predicted. (M.P.G.)

12845 VARIATSII KOSMICHESKIKH LUCHEI I ISSLEDOVANIE KOSMOSA. (Variations of Cosmic Rays and Study of Cosmos). L. I. Dorman. Moscow, Publishing House of the Academy of Sciences, 1963. 1028p.

A systematic analysis was made of data accumulated during the International Geophysical Years (1957–1962) using neutron monitors, ionization chambers, scintillation telescopes, balloons, satellites, and rockets. A critical review is given of the various hypotheses on the relation between cosmic ray variations and phenomena taking place in the cosmos. It is indicated that cosmic rays act as a sensitive probe in evaluating electromagnetic conditions in the earth's atmosphere, corpuscular fluxes, interplanetary space, solar atmosphere, galaxies, and metagalaxy. 1007 references. (R.V.J.)

Criticality Studies

12846 (NAA-SR-Memo-9207) CRITICALITY STUDY OF SRE CORE III FUEL ELEMENT FABRICATION. N. Ketzlach (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 18, 1963. Contract AT-11-1-GEN-8. 61p.

Nuclear safety criteria were determined for all process steps involved in the fabrication of 6.5 and 15.0% U^{235} enriched fuel rods. Criteria are also presented for the storage and processing of feedstock material and all intermediate forms of the fuel to the finished product. Although the method of packaging for shipment to Santa Susana was not determined at this time, general criteria for this operation are presented. The criteria presented for the 6.5% enrichment allow the use of the same equipment and batch size used in the melting and casting of UC for Hallam Core II (5.0% U^{235} enriched). This batch size is 60 kg uranium. Although the allowable batch sizes for the 15.0% U^{235} enriched fuel are smaller, they are compatible with the process and equipment planned for their melting and casting operations. A lazy susan containing a single annular ring of rods (for the sodium bonding operation) is safe for both enrichments independent of the number of rods in the ring and the degree of water flooding. (auth)

12847 (NAA-SR-Memo-9349) NUCLEAR SAFETY SRE STORAGE CELL (CORE III FUEL). N. Ketzlach (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 27, 1963. Contract AT-11-1-GEN-8. 4p.

It was determined that it is safe to store the SRE Core III elements (both enrichments) in an infinite array when positioned at the spacing dictated by the presently designed storage cell. This safety is independent of the degree of water flooding. However, it is dependent on the presence of the four-inch schedule 40 steel pipe positioned in each storage hole. Although the array is calculated to be subcritical ($k_\infty \sim 0.96$) even in the absence of the steel pipe, the accuracy of the method of calculation and the margin of safety are inadequate for assuming it to be safe under these conditions. (auth)

Direct Energy Conversion

Refer also to abstract 12726.

12848 (AD-401659) INVESTIGATION OF THE CURRENT DENSITY LIMITATIONS IN A THERMIONIC CONVERTER. Annual Summary Report. Coleman Kaplan (Marquardt Corp., Van Nuys, Calif.). Mar. 1963. Contract Nonr 2728(00). 44p.

Oscillations in grid voltage, output voltage and output current were observed over a wide range of operating conditions with a cesium-vapor triode. At higher cesium pressures, the oscillation period is an increasing function of the cesium pressure, which implies that the oscillations are controlled by scattering of positive ions in the interelectrode region. An approximate calculation of the ion accelerating voltage required to transfer ions from the middle of the emitter-collector space to the collector indicates a voltage of between 0.5 and 1.0 volt. Pulsed-discharge experiments were performed to investigate current-density limiting factors in a cesium diode operating in the intermediate temperature range. The experimental technique consisted of applying a pulsed discharge to the test cell and observing the effect upon output current after the pulse. When the diode operation was space-charge limited, a large increase in current was observed after the pulse. Reasonable agreement was obtained between the current density measured after a pulsed discharge and the saturation electron current density obtained from the literature. Measurements of the time required to establish equilibrium after the pulsed discharged provided information on the physics of cesium diode thermionic converters. (auth)

12849 (AD-406379) RESEARCH ON IMPROVED THERMIONIC CONVERTER FOR SPACE OPERATIONS. Semi-Annual Report No. 1, January 1, 1960–May 31, 1960. Karl G. Hernqvist and Fred M. Johnson (David Sarnoff Research Center, Princeton, N. J.). June 30, 1960. Contract AF19(604)-6175. 53p.

Thermionic converters are described in which the electron space charge is neutralized by positive ion injection into the interelectrode space. A novel method of representing the potential energy diagram for the plasma is described, which facilitates the understanding of the interaction between plasma and solids. Based on this model a detailed plasma energy balance is given. The operation of multi-work function cathodes is discussed. The relation between effective electron work function and vapor pressure is derived. A theoretical analysis of the space charge problem of a cesium plasma diode is made. Work on high anode temperature operation of the converter is also described. It is found that the cesium-covered anode is not suitable for high temperature operation for the low vapor pressure cesium diode. Work on a thermionic converter which may operate at 1000 to 1500°C is described. Here a third electrode whose sole purpose is that of generating ions is introduced. Based on the plasma model, the need

for proper bias voltage for this electrode is described. Work on two types of ion emitters is discussed. The different space charge states that are possible when ions and electrons are injected into the interelectrode space are discussed. Based on these considerations experimental work on plasma synthesis is described. Work on a versatile test cell for studies of materials and converter operation is described. (N.W.R.)

12850 (AD-407926) EXPLORATORY ENERGY CONVERSION STUDY OF PHOTON THERMIONICS. Quarterly Technical Progress No. 3. M. D. Gibbons (General Electric Co. Power Tube Dept., Schenectady, N. Y.). May 1963. Contract AF33(657)-9202. 13p.

The feasibility of enhancing the performance of the cesium vapor thermionic converter by photon processes was studied further. Two experimental converters designed specifically to keep the absorption path to a minimum were completed. Five radiation sources were tested with the converters. The only source that affected the converter operation was a xenon flash lamp, probably because the radiation intensity of the lamp is an order of magnitude greater than that of the other sources. Its effect in the ion rich region was to cause a 20% increase in the short-circuit current, while in the electron region changes of at least one order of magnitude were observed. In the latter region, however, the current is still space-charge limited. (auth)

12851 (AD-409015) DEVELOPMENT OF BARIUM OXIDE–URANIUM OXIDE–TUNGSTEN AND BARIUM OXIDE–URANIUM OXIDE–RHENIUM EMITTERS FOR USE IN NUCLEAR-HEATED THERMIONIC CONVERTERS. Annual Report, June 1, 1962 to June 30, 1963. Fay E. Gifford and Robert F. Hill (General Motors Corp. Research Labs., Warren, Mich.). Contract Nonr-3870(00). 70p.

Thermionic energy converters, which presently use unclad nuclear fuel emitters, operate in a high-temperature region (1700 to 2000°C) due to the electron emission characteristics of the emitter. In this temperature region, the life of the emitter is much lower than desired due to evaporation of the emitter material. A possible solution to this problem is to operate the nuclear heated thermionic emitter at a much lower temperature (1100 to 1300°C) where evaporation of the nuclear fuel in the emitter would be negligible over long periods of time. This report is concerned with the development of nuclear heated emitters that can be operated in the 1100 to 1300°C range with an electron emission capability of 1 to 10 amps/cm^2. (auth)

12852 (AD-409570) FEASIBILITY DETERMINATION OF A NUCLEAR THERMIONIC SPACE POWER PLANT. Quarterly Technical Progress Report, February 1, 1963 through April 30, 1963. (Aerojet-General Nucleonics, San Ramon, Calif.). Contract AF33(657)-8977. 26p. (AN-973)

Effort was continued to develop a nuclear thermionic space power plant. Technical work was divided into the following three tasks: liquid metal tubing–converter bond; thermal transport analysis; and series unit loop test. Attention was directed to degradation of converter performance resulting from series operation, the effect of emitter temperature variation on converter performance, and calculation of micrometeoroid armor requirements. (auth)

12853 (AD-409905) INVESTIGATION OF NON-EQUILIBRIUM IONIZATION FOR MHD ENERGY CONVERSION. Quarterly Report No. 5, March 15, 1963–June 15, 1963. G. W. Sutton (General Electric Co. Missile and Space Div., Valley Forge Space Technology Center, King of Prussia, Penna.). Contract AF33(657)-8298. 37p.

A theoretical and applied research program is being carried out, directed toward prolonging the lifetime of magnetohydrodynamic (MHD) energy converters by reducing the necessary operating temperatures to the range of 1000 to 2000°K. The process of interest is the use of the self-induced electric field in the MHD generator for electrical break-down of appropriate working fluids of interest. Work at present is directed toward the use of potassium for Rankine (vapor) cycles and argon plus cesium for studying the basic parameters of the break-down, although the results are applicable to gas (Brayton) cycles with certain nuclear reactors. (auth)

12854 (AD-411342) THE DEVELOPMENT OF A THERMIONIC CONVERTER MODULE SUITABLE FOR LIQUID METAL HEATING. Quarterly Technical Report No. 6. W. B. Hall and J. J. O'Grady (Radio Corp. of America. Special Electronic Components Div., Lancaster, Penna.). July 1963. Contract AF33(657)-8005. 38p.

An overall program to improve the performance and increase the reliability of thermionic energy converters for space applications is described. The development of a converter design that can be used in series to form a thermionic generator module capable of producing a three volt output when heated by liquid metal is described. The basic design produced in excess of 40 watts at 0.2 volt when electrically heated under specified conditions. A number of alternative arrangements of the emitter-heat source tubing were evaluated. In each case difficulties were experienced with the use of the niobium alloy. Tests have confirmed that the alumina-sprayed emitter leads and the sapphire insulation are compatible with cesium. Tests to define the performance limitations and life of the converter are continuing. (auth)

12855 (AFCRL-63-452) SINGLE-CRYSTAL THERMIONIC CONVERTER STUDIES. Scientific Report No. 3. H. F. Webster (General Electric Co. Research Lab., Schenectady, N. Y.). May 1963. Contract AF-19(604)-8424. 12p. (AD-407826)

A thermionic converter with an emitter made from a single crystal of tungsten cut to expose 16 cm^2 of 110 surface is described. Details of the cathode surface preparation, anode construction, and assembly techniques are presented, along with some operating characteristics. The power output was not as large as expected. Performance, particularly at low cesium pressures, improved after reprocessing. (auth)

12856 (AFCRL-63-607) RESEARCH STUDIES IN THE ROLE OF ADDITIVES IN THE LOW-TEMPERATURE CESIUM DIODE. Final Report. M. Silverberg, L. Haring, J. McInally, and M. Bernstein (Ford Instrument Co., Long Island City, N. Y.). May 1963. Contract AF19(604)-8486. 116p. (AD-411276)

A system which successfully permits various gases to be added in controlled amounts to a thermionic diode was constructed and utilized. The addition of neon and argon to a low temperature (1200°C) cesium diode resulted in improved performance at cesium bulb temperatures between 20 and 200°C. A tentative mechanism of cesium ion entrapment is forwarded as the basis for the enhanced discharge phenomena. (auth)

12857 (GESR-2017) DEVELOPMENT OF A NUCLEAR THERMIONIC FUEL ELEMENT. Annual Summary and Quarterly Progress Report No. 4, March 1, 1963–May 30, 1963. (General Electric Co. [Vallecitos

Atomic Lab.], Pleasanton, Calif.). Contract AT(04-3)-189. 59p.

Specimens of UO_2 clad in Mo and W were exposed in vacuum and cesium to 1900°C (for Mo) and 2000°C (for W). Careful post-examination has shown no interaction of UO_2 with Mo or W. Calculations indicate that evaporation of UO_2 through a clad vent hole into a cesium atmosphere will occur at a significantly lower rate than into a vacuum. Using a UO_2–W specimen vented to cesium (2 torr), the uranium loss was measured to be less by a factor of 100 than evaporation into a vacuum. A UO_2 plug which was formed in a W vent hole at 1730°C was easily dislodged by an internal xenon pressurization to 30 torr. Al_2O_3, BeO, ThO_2, and Y_2O_3 were exposed to cesium vapor (1 to 4 torr) in contact with either Mo or W with no interaction noticed. The design, development, operation, and evaluation of the nuclear thermionic converter are summarized as to present status. Information is presented on out-of-pile life testing, in-pile converter testing, reactor design and analysis, thermionic fuel element design and development, core physics, reflector control designs, thermionic reactor assembly, reflector design, and converter fabrication. (N.W.R.)

12858 (MND-2945-4) THERMIONIC DOUBLE-DIODE PROGRAM. Final Technical Report, November 1, 1962 through November 30, 1963. (Martin-Marietta Corp. Aerospace Div., Baltimore). Jan. 31, 1964. Contract AF33(657)-10077. 199p. (RTD-TDR-63-4244)

Results of an extensive research and development program were utilized to evolve the design of a fueled, double-diode thermionic module for out-of-pile testing. Two modules, each consisting of two diodes of cylindrical configuration connected electrically in series within a single sheath and utilizing a common cesium reservoir, were fabricated and tested. The emitters were the molybdenum claddings of the UO_2–Mo cermet bushings used to represent the nuclear fuel in the module. The two modules were tested for cumulative periods of 330 and 715 hours, respectively, at emitter temperatures between 1500 and 2000°C, and at a spacing of 17 to 18 mils. Output power densities of 1.5 to 6 watts/cm^2 were produced. Upon completion of the testing, each of the modules was disassembled and examined. Eight UO_2–Mo cermet fuel pellets clad with molybdenum were fabricated for study of materials compatibility problems. Dimensional stability, thermal conductivity, electrical resistivity, UO_2 diffusion, and thermionic emission were investigated. An improved fueled thermionic double diode for out-of-pile testing adaptable to in-pile operation was designed. (auth)

12859 (NP-13516) RESEARCH ON THE VORTEX MHD POWER GENERATOR. Final Report. (Thompson Ramo Wooldridge Inc. TRW Electromechanical Div., Cleveland). July 1963. Contract NAS 3-2526. 169p. (ER-5453)

Experimental and theoretical research on the vortex MHD power generator was conducted to determine its area of feasible application and practical lower limits of power output. Emphasis was given to advancing the concepts of turbulent vortex flows, to determining the operating characteristics of an experimental vortex MHD generator, and to improving the analytical methods for predicting generator performance. Turbulent vortex flow was investigated both analytically and experimentally. Analytical models, based on a pseudo-laminar analysis and in analogy with turbulent boundary layers, were developed for the hydrodynamics of turbulent jet-driven vortex flows with and without centerbodies. The mixing length theory that was developed previously for this application was found to be more complicated. Measurements of the flow distributions within a vortex chamber generally confirmed the validity of the analytical models; they also revealed the presence of relatively strong radial flows in the sidewall boundary layers of the low aspect ratio vortex chamber employed. A dual-jet vortex-type MHD generator was operated in the laboratory on cesium-seeded arc-heated argon plasmas. Of the several test attempts, two were aborted because of commercial equipment failures, and two failed to produce substantial power because of rapid graphite exhaust tube erosion and subsequent generator shorting. Otherwise, the materials problem was reduced to an acceptable level. Heat transfer and thermal control were established consistent with original estimates. A computer analysis for determining the performance of the vortex generator was developed. Real gas effects, including external heat transfer and viscous drag on the vortex sidewalls, were thereby included in the calculation of overall generator performance. The computer analysis was applied to the example of a high temperature combustion plasma operated vortex MHD generator; the generator performance was shown to be very competitive with other types of strongly competing open-cycle power conversion systems. 65 references. (auth)

12860 (NP-13591) RESEARCH PROGRAM RELATED TO VAPOR THERMIONIC CONVERTERS FOR NUCLEAR APPLICATION. Final Report. A. O. Jensen (Electro-Optical Systems, Inc., Pasadena, Calif.). Oct. 25, 1963. Contract NAS 3-2529. 115p. (EOS-3410(Final))

The effects of long time at temperature on the surface crystal structure of polycrystalline molybdenum substrates and how these changes in surface crystal structure relate to the performance of cesiated molybdenum emitters for use in cesium vapor thermionic converters for nuclear application are investigated. Vapor deposited tungsten coatings are evaluated for copper and molybdenum. Results are presented on long term cesiated emission tests from molybdenum with and without vapor deposited tungsten coatings. Information is included also on the design and operation of a thermionic electron emission microscope, chemical cleaning of molybdenum and tantalum, and calibration and stability of W–5% Re/W–26% Re thermocouples at 1000 to 1500°C. (N.W.R.)

12861 (NP-13594) RESEARCH AND DEVELOPMENT PROGRAM OF THERMIONIC CONVERSION OF HEAT TO ELECTRICITY. Third Quarter Report. (General Electric Co. [Vallecitos Atomic Lab.], Pleasanton, Calif.). Dec. 31, 1963. Contract NObs-88578. 6p.

Development for a thermionic converter is summarized. Information is mentioned briefly about shielding, uranium dioxide diffusion through tungsten, insulator materials development, cesium resistant metalizing, active-alloy sealing, metal-to-metal joining, and cesium corrosion testing. (N.W.R.)

12862 (PWA-2303) LIQUID METAL-HEATED SPACE RADIATOR-MOUNTED THERMIONIC GENERATOR. Second Quarterly Report, October 1 through December 31, 1963. F. C. Harter (Pratt and Whitney Aircraft Div., United Aircraft Corp., Hartford, Conn.). Contract AF33(657)-11320. 27p.

Thermionic generators suitable for liquid-metal heating in space radiator configurations are being evaluated. The thermionic generator discussed incorporates a tantalum alloy liquid metal containment tube insulated from a tungsten–rhenium alloy emitter by beryllia. The fab-

rication of generator subassemblies is described. The test system is also described. (auth)

12863 MHD POWER GENERATION. Thomas R. Brogan (Avco Corp., Everett, Mass.). IEEE (Inst. Elec. Electron. Engrs.), Spectrum, 1: 58-65(Feb. 1964).

The current status of MHD generator development, their future potentials, and problems preventing practical application are discussed. Particular emphasis is placed on the development of a large combustion-fired MHD generator. (R.E.U.)

12864 THEORETICAL CURRENT-VOLTAGE CURVE IN LOW-PRESSURE CESIUM DIODE FOR ELECTRON-RICH EMISSION. C. M. Goldstein (Lewis Research Center, Cleveland). J. Appl. Phys., 35: 728-9(Mar. 1964).

A potential model defined by limiting potential distributions was used in the computation with McIntyre's formulation of the space-charge analysis and an IBM-7090 computer. The change in slope of the current-voltage curve in the region of zero anode potential was considered. (R.E.U.)

12865 FLUID DYNAMIC STUDIES WITH A MAGNETOHYDRODYNAMIC GENERATOR. J. F. Louis, J. Lothrop, and T. R. Brogan (Avco-Everett Research Lab., Everett, Mass.). Phys. Fluids, 7: 362-74(Mar. 1964).

The results of a study of fluid mechanics of a large linear magnetohydrodynamic generator with a field strength of 33,000 G are presented. The experiment was designed to fulfill three requirements; predominant Lorenz force, important Hall effects, and substantial changes in the electric and thermodynamic properties of the gas. Studies of the electric properties of the fluid and of the effects of the surface temperature and geometry of the electrodes are described. The performance of the generator is analyzed under varying conditions of mass flow, magnetic field, seed concentration, exhaust pressure, and channel geometry. A comparison between a simple theory and the experimental results shows good agreement, indicating the feasibility of predicting magnetohydrodynamic generator performance. (auth)

12866 ENERGY CONVERSION. Sheldon S. L. Chang. Prentice-Hall International Series in Electrical Engineering. Englewood Cliffs, N. J., Prentice-Hall, Inc., 1963. 246p. $11.00.

The theory and fundamental techniques of direct energy conversion are discussed. Thermoelectric devices, thermionic cells, MHD converters, solar cells, and fuel cells are considered. (C.E.S.)

12867 ADVANCES IN MAGNETOHYDRODYNAMICS. Proceedings of a Colloquium at Sheffield University, October 1961. I. A. McGrath, R. G. Siddall, and M. W. Thring, eds. A Pergamon Press Book. New York, The Macmillan Company, 1963. 148p.

Magnetohydrodynamic generators and the problems associated with their development are discussed. Separate abstracts are prepared for the 14 papers presented. (C.E.S.)

For abstracts of individual papers see: 12791, 12868, 12869, 12870, 12871, 12872, 12873, 12874, 12875, 12876, 12877, 12878, 12879, and 13170.

12868 GAS BRAKING PROCESSES IN MHD-TYPE ELECTRIC GENERATORS. A. G. Bailey and D. J. Harris (Univ. of Sheffield, Eng.). p.7-17 of "Advances in Magnetohydrodynamics." New York, The Macmillan Co., 1963.

Processes that occur in an MHD generator during the braking of the gas stream are considered from a simplified microscopic point of view. It is assumed that charged particles in the duct move under the action of forces due to the applied magnetic field, electric fields along and transverse to the duct, and elastic collisions with gas atoms. The conclusion is reached that both electrons and positive ions will need to play a significant role if braking of the neutral gas stream is to be effective. (auth)

12869 SOME ASPECTS OF THE THEORY OF MHD GENERATION OF ELECTRICITY. P. L. Davies (Shell Research Ltd., Chester, Eng.). p.19-25 of "Advances in Magnetohydrodynamics." New York, The Macmillan Co., 1963.

The motion of a partially ionized gas through a magnetic field is discussed by considering the macroscopic equations of motion of the individual component gases consisting of neutrals, ions, and electrons. These equations with appropriate assumptions are applied to MHD generation of electricity. Their interpretation is followed by a brief discussion of coupling between the plasma and neutral gas. (auth)

12870 INITIAL EXPERIMENTS IN THE ELECTRICALLY DRIVEN 2cm SHOCK TUBE. R. M. Hobson and I. McLaren (Clarke, Chapman and Co., Ltd., Gateshead, Co., Durham, Eng.). p.55-63 of "Advances in Magnetohydrodynamics." New York, The Macmillan Co., 1963.

An electrically driven shock tube of coaxial geometry was set up to study some aspects of MHD power generation and preliminary results are reported. The velocity of the shock wave was measured using electrostatic probes inserted into the shock path through vacuum inlet stations, and the onset of luminosity behind the shock front examined using photomultipliers with light pipes inserted through the inlet stations. The open circuit voltage developed between two plane power extraction electrodes situated in a magnetic field transverse to the flow was also examined. (auth)

12871 THE INFLUENCE OF THERMAL IONIZATION PROCESSES ON THE DESIGN OF A FOSSIL FUELLED MHD POWER GENERATOR. H. Williams (R.P.E., Westcott, Bucks, Eng.), J. D. Lewis, and R. M. Hobson. p.65-78 of "Advances in Magnetohydrodynamics." New York, The Macmillan Co., 1963.

The process of thermal ionization of additives in flame gases is briefly considered before proceeding to the nonthermal ionization of the alkali metals in flame gases containing excessive amount of the free atomic hydrogen. It is pointed out that the necessary high electric conductivity for MHD power generation can be achieved at low temperatures if use can be made of this nonthermal ionization. A tentative scheme for a non-equilibrium, low pressure generator is proposed. The ionization of small solid particles, although promising at first sight, is shown to depend upon the controlled addition to very small particles having low surface work functions. There is little or no experimental work on the level of ionization in such systems. (auth)

12872 OPTIMUM MACH NUMBER IN THE DIRECT CURRENT MHD GENERATOR. J. C. Ralph (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.79-83 of "Advances in Magnetohydrodynamics." New York, The Macmillan Co., 1963.

In a linear MHD generator using thermal ionization, the electric conductivity of the working gas is an exponential function of the local gas temperature. To obtain maximum power per unit length of generator or maximum

power density at any section it is therefore necessary to select the correct gas velocity for any given total head temperature. Using the simple one-dimensional equation for power gradient and density in the generator a method is presented that enables the optimum Mach number for any given total head gas temperature to be calculated. Graphs are given of optimum Mach number vs total temperature for seeding gases and temperature ranges of current interest. (auth)

12873 THE CONSTANT TEMPERATURE MHD GENERATOR. D. T. Swift-Hook (Central Electricity Research Lab., [London]). p.85-94 of "Advances in Magnetohydrodynamics." New York, The Macmillan Co., 1963.

In a MHD generator in which power is derived solely from the kinetic energy of the flow and not from the potential energy of the gas, the temperature remains constant. The available efficiency does not then depend upon the ratio of the load to the internal resistance, but the length required to realize that efficiency does. For a given entrance Mach number this length is a minimum when there is a large duct expansion that gives a large internal resistance relative to the load. The shortest possible braking length for a γ of 1.33 is for an entrance Mach number of 0.65 which gives a very low maximum efficiency (6.7 per cent), so that a compromise must be reached between duct length and efficiency. (auth)

12874 A MAGNETOPLASMADYNAMIC POWER GENERATION EXPERIMENT. B. C. Lindley (C. A. Parsons and Co., Ltd., Newcastle upon Tyne, Eng.). p.95-102 of "Advances in Magnetohydrodynamics." New York, The Macmillan Co., 1963.

Progress on the construction and commissioning of a closed-cycle magnetoplasmadynamic power generation experiment is described. The facility is designed to provide a continuous flow of purified helium-cesium (or alternative composition) plasma. The first stage in the associated experimental program is centered on a constant area tranverse magnetic field generator duct, although it is planned to substitute generator sections with other flow-field configurations at a later stage in the experimental program. Emphasis will be placed upon gaining an understanding of the physical processes involved in the extraction of electric energy through the interaction of a flowing plasma with a magnetic field, enabling an assessment to be made of the feasibility and utility of magnetoplasmadynamic electric power generation. (auth)

12875 THE MERCURY CLOSED-CYCLE EXPERIMENT. J. G. Mack and D. R. Medhurst (Central Electricity Research Labs., [London]). p.103-8 of "Advances in Magnetohydrodynamics." New York, The Macmillan Co., 1963.

An experimental apparatus, with which the MHD interaction and various associated processes can be investigated with a degree of precision not attainable with combustion-jet or arc-jet devices is described. The particular advantages consequent upon the use of an extra-thermal ionization method and the use of mercury as the working fluid, are indicated. (auth)

12876 A.C. GENERATION. W. F. S. Bugden, R. B. Clark, D. T. Law, P. G. Meier, and S. W. Twaites (Central Electricity Research Labs., [London]). p.109-12 of "Advances in Magnetohydrodynamics." New York, The Macmillan Co., 1963.

Experiments are described in which a-c MHD power was generated using a pulsed combustion source with a steady magnetic field and both electrode and inductive coupling. The dependence of the output voltage on various parameters was investigated for a simple analog of the inductive coupling case in which a metal propeller was rotated in between a pair of coils mounted on the pole faces of a permanent magnet. It is concluded that it is possible to generate a-c MHD power using inductive coupling but at power levels that are small compared with those obtained using electrode coupling or the equivalent d-c case. (auth)

12877 EXPERIMENTS WITH A MAGNETOHYDRODYNAMIC FUEL OIL RIG. J. Maycock, J. A. Noë, and J. K. Wright (Central Electricity Research Labs., [London]). p.113-16 of "Advances in Magnetohydrodynamics." New York, The Macmillan Co., 1963.

Practical considerations are shown to give preference to the open cycle as against closed cycle magnetohydrodynamic generator and the problems hindering its development are discussed. These problems are primarily concerned with generator walls and electrodes. Experimental work carried out by the C.E.G.B. is then described. Electrodes of carbon and water cooled copper were investigated in a 2,800°K combustion gas stream. The techniques of measuring the electric characteristics are described, and the general results compared with those of other workers. (auth)

12878 DEVELOPMENTS IN THE MAGNETOHYDRODYNAMIC GENERATION OF ELECTRICITY IN THE UNITED STATES OF AMERICA. David C. Dryburgh (Rolls-Royce Ltd., [Derby, Eng.]). p.117-32 of "Advances in Magnetohydrodynamics." New York, The Macmillan Co., 1963.

A short review of the theoretical and experimental work relating to power conversion that was reported at the second symposium on Engineering Aspects of Magnetohydrodynamics is presented. Among the topics included are a discussion of some of the early experimental results obtained in laboratory-sized direct-current ducts, some of the main features of the design studies for full scale ducts, basic results, both theoretical and experimental, on gas conductivity, and some of the methods proposed to extract a-c power directly and the requirements to be met in order to make them possible. (auth)

12879 THE STEPS NECESSARY ON A NATIONAL BASIS TO PRODUCE A PRACTICAL MHD GENERATOR. M. W. Thring. p.133-8 of "Advances in Magnetohydrodynamics." New York, The Macmillan Co., 1963.

Four essential stages of development for producing a practical MHD generator on a national basis are discussed. Fundamental applied research, development of the small pilot plant, the large pilot plant, and the industrial plant are considered. (C.E.S.)

12880 P_4S_2 COOLED THERMOELECTRIC REACTOR PLANT CONCEPTUAL DESIGN. Charles Murphy (Martin-Marietta Corp., Baltimore). 32p. (CONF-187-39)

From American Nuclear Society Meeting, New York, Nov. 1963.

A feasibility study of a P_4S_2-cooled thermoelectric portable nuclear power plant fueled by zirconium–uranium hydride and capable of producing 1300 kw(e) is presented. The system concept development, thermoelectric generator design, reactor design, and other subsystems are discussed. The plant features a compact thermoelectric generator using thin large area elements of high efficiency, a high-temperature low-pressure coolant, natural circulation of both primary and secondary coolants, and a solid-state conversion system. (R.E.U.)

12881 A WATER COOLED THERMIONIC PORTABLE POWER PLANT. Gareth Reed (Martin-Marietta Corp., Baltimore). 23p. (CONF-187-38)

From American Nuclear Society Meeting, New York, Nov. 1963.

A water-cooled, solid-moderated, thermionic reactor system is described in which the complexity of systems external to the core is reduced greatly. The plant is of the Army PM-type and is capable of 1 Mw(e) net. The thermionic reactor core is based on "ignited-mode" experimental data. (R.E.U.)

12882 IMPROVEMENTS IN OR RELATING TO THERMIONIC CONVERTERS. (to General Dynamics Corp.). British Patent 947,281. Jan. 22, 1964. Priority date Oct. 20, 1961, United States.

A thermionic converter or generator with a method of controlling the anode work function, and therefore the efficiency, of the generator during operation is patented. The converter consists of a high-temperature cathode and a low-temperature anode in an evacuated envelope. The electrodes are electrically connected through an external load to obtain electrical energy. A readily ionizable material, such as an alkali metal, provides the carrier gas at low pressure from a storage reservoir. An anode-work-function-reducing gas, preferably H, is released from a second reservoir through a barrier, which is permeable to H, but not to the carrier gas. The anode work function is controlled by controlling the amount of H in the converter, which is accomplished by regulating the temperature of the hydride from which the H is released. The recommended carrier gas is ionized Cs, the recommended barrier material is Pd, and the high-temperature cathode may be a fuel element in the reactor core. (M.P.G.)

12883 THERMIONIC ENERGY CONVERTER. Karl-Georg Guenther and Walter Haenlein (to Siemens-Schuckertwerke AG). U. S. Patent 3,120,621. Feb. 4, 1964. Priority date Dec. 29, 1960, Germany.

A thermionic converter is described that comprises a low-pressure diode and a heated mixture of a driving gas and readily ionizable metal addition finely distributed in the driving gas. The metal is ionized at a metallic cathode, and the ions in turn are electrically discharged at the anode. Terminal pieces are provided at the electrodes for extraction of the electrical energy. The metal addition is Li, Na, K, Rb, or Cs. The driving gas is argon. Either a-c or d-c may be generated with proper refinements. (R.E.U.)

12884 MATRIX EMITTER FOR THERMIONIC CONVERSION SYSTEMS. George A. Haas (to U. S. Navy). U. S. Patent 3,121,048. Feb. 11, 1964. Filed June 29, 1962.

A matrix-type thermionic emitter that is fission-heated in a neutron flux is described. Low-temperature operation and continuous renewal of the active emissive barium surface during operation are achieved. The matrix emitter is composed of a pressed powder mixture of UC and barium, calcium aluminate and zirconium hydride or molybdenum as a reducing agent. (R.E.U.)

12885 MAGNETOHYDRODYNAMIC GENERATOR. Alfred Kaech (to Brown, Boveri and Cie). U. S. Patent 3,122,663. Feb. 25, 1964. Priority date Nov. 14, 1959, Switzerland.

An electrodeless MHD generator is described that comprises a channel of annular cross section traversed by hot ionized gas. The channel extends between the cores and shells of transformers with yokes formed by radial spokes. Means are provided for generation of magnetic fields transversely to the gas flow and radially through the channel. The magnetic field is generated by a six-phase current source. An inductance method is used to extract the a-c through the secondary windings of the transformer. (R.E.U.)

Elementary Particles and Radiations

Refer also to abstracts 12448, 12460, and 13117.

12886 (AD-415714) RATIO LIMIT THEOREMS FOR CASCADE PROCESSES. P. E. Ney (Cornell Univ., Ithaca, N. Y.). May 1963. Contract Nonr-401(43). 27p.

The evolution of a family of particles, each of which is characterized by a real-valued quantity called its energy, is studied. It is assumed that the process originates at time t = 0 with a single parent particle of energy X_0, which after a time T splits into N other particles of energies X_1 to X_N, respectively. Each of these offspring particles then behaves as a parent; its behavior depending only on its energy, and being independent of any other existing particles or of the history of the process. (auth)

12887 (AEET/CD/19) PERTURBATION THEORY OF MANY-PARTICLE SYSTEM. [PART] 2. P. G. Khubchandani and C. Manohar (India. Atomic Energy Establishment, Trombay). 1963. 16p.

A perturbation theory that is valid for systems with continuous energy spectra as well as systems with discrete spectra is formulated. Van Hove's formulation is derived as a special case. (D.C.W.)

12888 (AFOSR-4742) RADIATIVE CORRECTIONS TO HIGH-ENERGY SCATTERING PROCESSES. Technical Note No. 8. N. Abensour (Paris. Universite, Orsay. Ecole Normale Superieure. Laboratoire de Physique Theorique et Hautes Energies); and D. R. Yennie (Minnesota. Univ., Minneapolis. School of Physics). Jan. 1963. 60p. (AD-409440)

A unified treatment is presented of radiative corrections to a class of scattering experiments in which either (but not both) the scattered or recoil particle is detected. The recoil kinematics are properly treated, and the calculation is simplified by retaining only terms of logarithmic order. The general results are applied to specific practical examples in which radiative corrections are likely to be important. Except possibly for the case of compton scattering with nearly maximum momentum transfer, the errors are estimated to be less than 2% of the cross section. (auth)

12889 (CERN-63-37) THE 1963 NPA SEMINARS—THE NEUTRINO EXPERIMENT. C. Franzinetti, ed. (European Organization for Nuclear Research, Geneva). 301p.

The apparatus, theory, and previous experiments are discussed for high-energy neutrino experiments. A separate abstract was prepared for each paper presented. (C.E.S.)

For abstracts of individual papers see: 12448, 12449, 12450, 12451, 12452, 12800, 12890, 12891, 12892, 12893, 12894, 12895, 12896, and 13040.

12890 (CERN-63-37(p.1-20)) THEORETICAL INTRODUCTION. J. S. Bell (European Organization for Nuclear Research, Geneva).

Conserved vector current theory, the intermediate vector boson, muon and electron conservation, muon-electron universality, neutral currents, vector particle

exchange, and form factors in ν + n and $\bar{\nu}$ + p interactions are discussed. (C.E.S.)

12891 (CERN-63-37(p.21-32)) PRODUCTION AND DECAY OF THE VECTOR BOSON. M. Veltman (European Organization for Nuclear Research, Geneva).

An experiment in which the intermediate vector boson may be produced and conclusions that can be drawn from the experiment are discussed. The experiment consists in scattering the neutrino ν_μ in the Coulomb field of a nucleus. The vector boson decay products are also discussed. Values of the cross section for vector boson production on Al and Cu are calculated as a function of neutrino energy. (C.E.S.)

12892 (CERN-63-37(p.33-41)) THE BROOKHAVEN NEUTRINO EXPERIMENT. J. M. Gaillard (European Organization for Nuclear Research, Geneva).

The experimental apparatus and the final interpretation of the experimental results for neutrino-nucleon interactions are discussed. The neutrinos were produced in the decay of pions and kaons from 15-Bev proton bombardment of a beryllium target. (C.E.S.)

12893 (CERN-63-37(p.97-109)) NEUTRINO FLUX CALCULATIONS. S. van der Meer and K. M. Vahlbruch (European Organization for Nuclear Research, Geneva).

A description is given of the method used for calculating the neutrino flux at detectors, taking into account the focusing provided by a neutrino horn. Results of the computations for various conditions are presented. (auth)

12894 (CERN-63-37(p.111-29)) NEUTRINO SPECTRA FROM THE TWO-BODY DECAY OF RELATIVISTIC PARENTS. C. A. Ramm (European Organization for Nuclear Research, Geneva).

The production of neutrino fluxes at a given distance from a limited isotropic source of monoenergetic relativistic parents (pion and kaons) is considered in terms of the angular divergence and flight path. The relation between neutrino fluxes from pencil beams and slightly divergent beams of parents is discussed, and the matching between the arrangement of the neutrino detectors and the degree of parent focusing is examined. The neutrino fluxes achievable in principle by pencil focusing of known parent spectra from the proton synchrotron are calculated. (C.E.S.)

12895 (CERN-63-37(p.163-77)) EXPECTED FREQUENCIES OF EVENTS AND EVALUATION OF DATA IN THE SPARK CHAMBER EXPERIMENT. R. Salmeron (European Organization for Nuclear Research, Geneva).

From the knowledge of the neutrino spectrum an attempt is made to foresee what the events are going to look like if certain theoretical assumptions are correct. Total cross sections for the reactions ν + p, ν + Al, and ν + Cu, which are mediated by a vector boson, are presented as a function of neutrino energy. (C.E.S.)

12896 (CERN-63-37(p.179-201)) ELEMENTARY THEORY OF HIGH-ENERGY NEUTRINO INTERACTIONS. M. Veltman (European Organization for Nuclear Research, Geneva).

Cross sections and lifetimes calculated from lagrangians or hamiltonians are considered, and fields are defined for particles with definite momentum with the proper normalization factors. Scalar, spinor, and vector fields are discussed. Vector boson production and muon wave functions are also investigated. (C.E.S.)

12897 (EFINS-63-67) BOUNDARY CONDITIONS FOR A PARTIAL-WAVE AMPLITUDE. A. P. Balachandran (Chicago. Univ., Enrico Fermi Inst. for Nuclear Studies and Chicago. Univ.). Sept. 1963. Contract AT(11-1)-264. 32p.

A partial-wave amplitude is frequently subject to constraints that specify its values at a given set of points. This happens, for instance, when one insists on its correct threshold behavior. Such constraints are investigated, and a class of inequalities, which are necessary conditions for the existence of such an amplitude, are derived. (auth)

12898 (EFINS-63-72) SOME INEQUALITIES FOR THE FORWARD SCATTERING AMPLITUDE. A. P. Balachandran (Chicago. Univ., Enrico Fermi Inst. for Nuclear Studies and Chicago. Univ.). Oct. 1963. Contract AT(11-1)-164. 33p.

A class of inequalities involving the real parts of the forward scattering amplitude at arbitrary energies and certain finite integrals over total cross sections are derived. These should prove useful in the resolution of phase shift ambiguities in the analyses of scattering data, and are sufficiently flexible to be applied even in situations where, for instance, the magnitude of the residue at a pole is not known. (auth)

12899 (IFA-FT/50) OVERLAP INTEGRAL FOR THE REACTIONS WITH H^3 OR He^3. Aurel Săndulescu (Academia R. P. R. Institutul de Fizică Atomică, Bucharest); and Ovidiu Dumitrescu (Bucharest. Universitatea "C. I. Parhon"). July 1963. 21p.

The calculation of the reduced widths on the basis of the nuclear models reduces to the calculation of the so-called overlap integral between the spatial wave function of the nucleons that take part in the reaction and the product of orbital momentum and intrinsic wave functions of the emitted particle. An explicit expression for the overlap integral occurring in the reactions with H^3 or He^3 was obtained. One uses for the wave functions of the individual nucleons harmonic oscillator wave functions and for the spatial wave function of H^3 or He^3 an exponential-type function. (auth)

12900 (JINR-P-1476) NEKOTORYE METODICHESKIE OSOBENNOSTI OPYTA Po p-p UPRUGOMU RASSEYANIYU S ISPOL'ZOVANIEM VNUTRENNEI MISHENI SINKHROFAZOTRONA. (Some Technical Details of Elastic pp Scattering Experiment Employing an Internal Target). V. A. Nikitin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1963. 14p.

A method is proposed for a mathematical analysis of the energy spectra of the recoil protons travelling at a fixed angle from the internal target of the accelerator. The data were analysed on the electronic computer. The purpose of the calculations is to find the magnitude of elastic p-p scattering. (auth)

12901 (JINR-P-1481) UPRUGOE RASSEYANIE π^--MEZONOV NA PROTONAKH PRI IMPUL'SE 4 Gev/s. (Elastic π Meson-Proton Scattering at 4 Gev/c). Z. F. Korbel, M. G. Shaffranova, A. I. Zlateva, P. K. Markov, T. S. Todorov, Kh. M. Chernev, N. Dalkhazhav, and D. Tuvdendorzh (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1963. 9p.

The elastic π^--p scattering at the momentum of 4.0 Bev/c was investigated in the momentum transfer range of $0.0046 < |t|\ (\text{Bev/c})^2 < 0.115$. The emulsion technique was used. 222 elastic scattering events were identified. The data agree with the assumption about the absence of the real part of the scattering amplitude. The total elastic scattering cross section was found to be $\sigma_{el} = (5.9 \pm 0.5)$ mb. The Bev/c^{-2} for $0.01 < |t|\ (\text{Bev/c})^2 < 0.2$. (auth)

12902 (JINR-P-1487) RASSEYANIE NEITRINO NA POLYARIZOVANNOM ELEKTRONE. (Neutrino Scatter-

ing on a Polarized Electron). S. S. Gershtein and V. N. Folomeshkin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 2p.

A spin dependence of the cross section for neutrino scattering on polarized electrons is described. This dependence may be useful for the experimental identification of the $\nu-e$ scattering process against the background. (auth)

12903 (JINR-P-1490) VZAIMODEISTVIYA MEZONOV. (Interactions Between Mesons). V. S. Barashenkov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 56p.

A review is given of the experimental and theoretical data on $\pi-\pi$, K-π, and K-K interactions. (auth)

12904 (JINR-P-1491) K TEORII REGULYARIZATSII URAVNENII DVIZHENIYA KLASSICHESKIKH CHASTITS (S UCHETOM SAMODEISTVIYA). (On a Regularization of Equations of Motion for Classical Particles (With Account of Self-Action)). L. G. Zastavenko (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 14p.

A method is proposed for regularizing the equations of motion for classical particles in a field. The main idea is that the field equation and the supplementary condition requiring that the motion with constant velocity would be the only possible motion of a free particle determine the equation of motion for particles uniquely. (auth)

12905 (JINR-P-1513) O VOZMOZHNOM METODE OPREDELENIYA MAGNITVOGO MOMENTA Σ^+-GIPERONA. (On a Possible Method for Determining the Magnetic Moment of a Σ^+ Hyperon). V. L. Lyuboshits and M. I. Podgoretskii (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1964. 10p.

A method is proposed to determine the magnetic moment of a Σ^+ hyperon that does not require strong magnetic fields. This method is based on the depolarization of charged particles in condensed media. It is shown that the magnitude of the magnetic moment of a Σ^+ hyperon can be, in principle, found from the analysis of experimental data on asymmetry in the decay $\Sigma^+ \to p + \pi^0$ in flight or at rest. (auth)

12906 (JÜL-110-HP) PHOTOERZEUGUNG VON POSITIVEN π-MESONEN AN WASSERSTOFF IM GEBIET DER ERSTEN RESONANZ. (MESSUNGEN MIT EINEM REICHWEITETELESKOP, TEIL I). (Photoproduction of Positive π Mesons in Hydrogen in the Region of the First Resonance. Part I. Measurements with a Range Telescope). Dietrich Freytag (Kernforschungsanlage, Jülich, Germany). Mar. 1963. 92p.

The effective cross sections for the simple production of mesons (π^+) on protons by gamma radiation, in the reaction $\gamma + p \to \pi^+ + N$, were measured using a range telescope. The electronic processes for the signal produced by the scintillation counter and corrections for the measured results are considered. Results are presented in tables and graphs. (M.C.G.)

12907 (NP-13602(Vol.I)) LECTURE NOTES ON THEORETICAL APPROACHES TO RELATIVISTIC PARTICLE PHYSICS. VOLUME I. Technical Report No. 303. Robert Karplus (Maryland. Univ., College Park). June 1963. 94p.

The S-matrix approach is reviewed. Non-relativistic potential scattering is treated to illustrate the analyticity involved. The Fredholm method for extending the analyticity of the scattering amplitude is presented, together with the Mandelstam representation. Analyticity in perturbation theory is also considered. (D.C.W.)

12908 (NP-13602(Vol.II)) LECTURE NOTES ON THEORETICAL APPROACHES TO RELATIVISTIC PARTICLE PHYSICS. VOLUME II. Technical Report No. 303–Part II. Robert Karplus (Maryland. Univ., College Park). Aug. 1963. 116p.

The consequences of the analyticity considered in Volume I are investigated. Dispersion relations for expressing analyticity properties are considered, particularly the Mandelstam representation. An interpretation of Regge poles is derived. The results obtained using the methods outlined are then reviewed, and the symmetry approach is outlined. (D.C.W.)

12909 (NP-13627) ON THE TRANSFORMATION OF THE TRANSPORT EQUATION FOR SOLVING DEEP PENETRATION PROBLEMS BY THE MONTE CARLO METHOD. M. Leimdoerfer (Sweden. Försvarets Forskningsanstalt, Stockholm). Feb. 1964. 12p.

A modification of the previously obtained exponential transformation of the Boltzmann transport equation that removes a singularity in the transformed scattering kernel is described. The effect is obtained by limiting the tracks of the particles to the problem boundary, whereby a zero virtual cross section may be permitted. A sampling technique for the new intercollision distance is given. (auth)

12910 (PAN-450/VII) ANGULAR CORRELATIONS IN A CERTAIN TYPE OF MULTIPARTICLE PROCESSES. J. Werle (Polish Academy of Science. Inst. of Nuclear Research, Warsaw and Warsaw. Univ.). July 1963. 24p.

A relativistic partial wave expansion for describing angular correlations in certain multiparticle processes is derived. Approximations that restrict the sums involved in the expansion are discussed, and the expansion is applied to the interaction $p^- - p \to \bar{K} - K - \pi^+ - \pi^- - \pi^0$ for the case of slow antiprotons. The angular correlations for the interaction are presented. (D.C.W.)

12911 (PAN-453/VII) FIXED-ANGLE DISPERSION RELATIONS FOR $\bar{K} + N \to \pi + Y$ AMPLITUDES NEAR AND BELOW THRESHOLD. A. Jurewicz (Warsaw. Univ. Inst. of Theoretical Physics) and M. Swiecki (Polish Academy of Sciences. Inst. of Nuclear Research, Warsaw). July 1963. 37p.

Using fixed angle dispersion relations for the ($K-N-\pi-Y$) vortex, a set of integral equations for partial amplitudes of the interactions $\bar{K} + N \to \pi + Y$ and $\pi + N \to K + Y$ is derived. An approximate method for solving the equations using experimental information on resonances is outlined. (auth)

12912 (TID-7686(p.35-41)) FLUXES OF SECONDARY PARTICLES FROM ULTRARELATIVISTIC PROTON ACCELERATORS. G. Cocconi (Cornell Univ., Ithaca, N. Y.).

Some calculations of secondary fluxes by an empirical method are summarized, together with some considerations on the characteristics of high-energy N-N interactions. The production of secondaries in p-$\bar{p}$ annihilation, apparently, can be treated as a special case of secondary production in N-N interactions. (D.C.W.)

12913 (TID-7686(p.69-107)) REPORTS ON THE EXPERIMENTAL STATUS OF NEW RESONANCES OR HIGHLY UNSTABLE PARTICLES. W. Walker (Wisconsin. Univ., Madison).

Some experiments on meson(π) production and resonances in p-d, π^--p, p-p, π^+-d interactions are discussed, together with the currently known particles and data on mesons(η) and mesons(ρ). (D.C.W.)

12914 (TID-7686(p.109-29)) SPECULATIONS ON VECTOR MESONS. J. J. Sakurai (Chicago. Univ.).

The vector theory of strong interactions, R symmetry, and rare modes and widths of ρ, ω, η, and K^+ are discussed. Some experiments of immediate interest are also indicated. (D.C.W.)

12915 (TID-7686(p.131-4)) EVIDENCE CONCERNING PION-PION INTERACTIONS BELOW THE 765-Mev RESONANCE. Martin L. Perl (Michigan, Univ., Ann Arbor).

The interaction $\pi^- - p \rightarrow \pi^- - \pi^0 - p$ at incident pion energies of 775 and 871 Mev was investigated. The results support a two-pion resonance with T = 1 at 575-Mev. Observations on the 765-Mev resonance in this and other $\pi^+ - p$ interactions are also discussed. (D.C.W.)

12916 (TID-20112) A POSSIBLE METHOD OF DETERMINING THE MOMENT OF CHARGE OF ν_e. T. D. Lee (Columbia Univ., New York) and A. Sirlin (New York Univ., New York). [1963]. Contract AT(30-1)-1934. 15p.

Theory for experimentally determining the charge moment by absolute measurement of the total cross sections for the interactions $\nu_e - e^- \rightarrow \nu_e - e^-$ and $\bar{\nu}_e - e^- \rightarrow \bar{\nu}_e - e^-$ or by studying the (4-momentum transfer)^2 dependence of the differential cross sections is presented. (D.C.W.)

12917 (UCRL-11125) STUDY OF DYNAMICAL S-MATRIX EQUATIONS WITH REGGE BEHAVIOR (thesis). C. Edward Jones (California. Univ., Berkeley. Lawrence Radiation Lab.). Oct. 31, 1963. Contract W-7405-eng-48. 99p.

The modified N/D equations with Regge behavior, originally proposed by Chew, are studied. An exact version of the dynamical equation is formulated, and it is shown to be of a combined Wiener-Hopf Fredholm type. The principle of Maximal Analyticity of the Second Degree is demonstrated as a tool for defining unambiguously and without arbitrary parameters the dynamical equations and their solutions at low values of angular momentum. The so-called strip approximation to the equations, embodying a crossing symmetric Regge representation, is discussed; and the validity of the approximation scheme is verified. The high energy behavior of the Regge poles and residues that result as solutions to the dynamical equations in both the exact problem and in the strip approximation are also investigated. (auth)

12918 (UCRL-11155) K^-p ELASTIC SCATTERING AT 1.22 Bev/c (thesis, Part II). John H. Munson (California. Univ., Berkeley. Lawrence Radiation Lab.). Dec. 20, 1963. Contract W-7405-eng-48. 35p.

Three thousand K^--p elastic scatterings at 1.22 Bev/c were studied. Fitting of the corrected elastic-scattering center-of-mass angular distribution suggests that terms to $\cos^6\theta$ are needed, although a fit to $\cos^5\theta$ is certainly not excluded. The elastic-scattering data, together with the published charge-exchange data from the same exposure and data at 1.34 Bev/c, are subjected to a partial-wave analysis, parameterized in terms of K^--p resonances at 1765, 1815, and 2100 Mev. (The Y_1^1 (2100) parameterization, with width 180 Mev and elasticity 0.35, is suggested by the K^--p and K^--n total cross section curves.) The predicted angular distributions are in good agreement with the experimental distributions. Dalitz plots are presented for the partially analyzed three-body reactions appearing in the two-prong topology, and obtained as a by-product. (auth)

12919 APPLICATION OF THE THEORY OF THE SYMMETRIC GROUP TO THE SEVERAL-NUCLEON PROBLEM. Hormoz Mahmoud and Richard K. Cooper (Univ. of Arizona, Tucson). Ann. Phys. (N. Y.), 26: 222-38(Feb. 5, 1964).

The problem of separating the spin and isospin dependence from the equation of motion of a system consisting of a small number of nucleons is considered. Certain coefficients, analogous to those used in the theory of angular momentum, are introduced, and it is demonstrated that with their use the equation of motion may be reduced to a system of coupled differential equations involving the position coordinates only. Some of the properties of these coefficients and their connection with the permutation group are discussed. Tables of coefficients for three-nucleon and four-nucleon problems are also included. (auth)

12920 PROPERTIES OF THE BOUND STATES EMBEDDED IN THE CONTINUUM. Luciano Fonda (Università, Parma, Italy and Istituto Nazionale di Fisica Nucleare, Parma, Italy) and Gian Carlo Ghirardi. Ann. Phys. (N. Y.), 26: 240-6(Feb. 5, 1964).

The energy dependence of the matrix element connecting the state vector describing the generic bound state embedded in the continuum with the unperturbed states is investigated in detail. The energy behavior is such that the scattering matrix turns out to be not infinite at the energy of the bound state embedded in the continuum. The asymptotic spatial behavior of the state vectors relative to these kinds of eigenvalues is analyzed. There results that the two-particle projected part of these vectors determines in most cases the asymptotic behavior of such states. (auth)

12921 REPRESENTATION OF SCATTERING AMPLITUDE. I. P. Nedelkov (Joint Inst. for Nuclear Research, Dubna, USSR). Ann. Physik (7), 12: 1-13(Oct. 1963). (In German)

The different ways for expressing the dependence of the scattering amplitude h(z) on its argument z are called representations of the scattering amplitude. In the component representation, h(z) is expressed as a sum of more elementary functions. The component representation was proved to be unique. The determination of h(z) in regions with singularities was carried out for the cases which were inaccessible for Oehmes method. In suitable representations algebraic equations of the Low type were derived. These equations may have an advantage over the dispersion ones because the usual analytical properties of the scattering amplitude was necessary for their derivation. The possibilities for a natural classification of the scattering amplitudes are discussed. (auth)

12922 CALCULATION OF THE MULTIPLE SCATTERING OF γ-RADIATION OF FLAT SOURCES. F. A. Makhlis. At. Energ. (USSR), 15: 508-10(Dec. 1963). (In Russian)

Calculations of the attenuation of γ radiation from rectangular sources without taking the multiple scattering into account, may result in serious errors. In order to clarify this problem, the dose rate from a flat Co^{60} source beyond a shield made of water, Al, and Fe was calculated considering multiple scattering. The build-up factor was also determined. It was assumed that no self-absorption takes place and that the strength of the source remains constant. For the purposes of the calculation, the surface of the source was divided into small squares and the contribution of each surface element to the overall dose rate at a given point beyond the shield was determined. Corrections were made for the thickness of the shield and the inclination of the beam. It was found that the build-up factor of a point source may be used for square sources, if the ratio of the source width, b, to the distance from the source to the point considered, h, satisfies the condition $b/h \leq 0.5$, while $\mu r \leq 2$, where μ is the linear attenuation coefficient

and r is the thickness of the shield; the error does not exceed 50% if b/h = 5. (TTT)

12923 ON THE PROBLEM OF THE STABILITY OF ZERO MASS PARTICLES. Andor Frenkel. At. Kozlemen., 11: 439-447(1963). (In Hungarian)

It is shown that neither the principle of Lorentz covariance, nor the energy-momentum and angular momentum conservation laws exclude the possibility that a particle of mass zero is unstable. For m = 0 the lifetime t cannot be expressed by means of the invariant space-time interval $\tau = (t^2 - c^{-2}x^2)^{1/2}$ because $\tau = 0$; nevertheless, the lifetime remains a meaningful quantity. It is pointed out that the case is similar for the energy of the photon: the latter is also a meaningful quantity in spite of the fact that it cannot be expressed by the mass of the photon. Finally, it is proved that both for the m > 0 and m = 0 case the ratio of the lifetime to the energy is an invariant quantity, which can be used as a measure of the instability of the particle. (auth)

12924 ENERGY LEVELS OF MESIC ATOMS. Magda Ericson (Université, Lyon). Compt. Rend., 257: 3831-4 (Dec. 16, 1963). (In French)

The positions of the energy levels and their length were calculated in mesic atoms using the optical model for the π meson-nucleus interaction. Except for the 1s state, it is shown that these quantities can not be calculated by the ordinary theory of perturbations because of the modification of the meson mass in nuclear matter. The values of the optical parameters at low energy were deduced from experimental results. (tr-auth)

12925 CROSS SECTION FOR THE INTERACTION OF ANTIPROTONS OF MOMENTUM 3 Bev/c WITH COMPLEX NUCLEI. Francoise Bartholin, Bernard Tinland, Albert Bernheim, Brigitte Brami-Dépaux, Jacques Bermond, and Vicente Villar Perez (Centre de Physique Nucleaire, Lyon; Laboratoire de Physique-Enseignement, Paris; Laboratoire de Physique Corpusculaire, Caen, France; and Laboratoire de Physique Nucleaire, Clermont-Ferrand, France). Compt. Rend., 257: 3867-9(Dec. 16, 1963). (In French)

The free path of 3.0-Bev/c antiprotons with the complex nuclei of photographic emulsions was determined. By considering the corrections necessary because of beam contamination, the free path was found to equal 28.8 cm. The interaction cross sections are compatible with a p-n cross section equal to 112^{+23}_{-24} mb. (tr-auth)

12926 SOME RARE CASES OF NONMESIC HYPERFRAGMENTS. Germain Baumann, Henri Braun, and Pierre Cuer. Compt. Rend., 257: 4180-2(Dec. 23, 1963). (In French)

The ionographic method was used to show the existence of some rare hyperfragments not reported in the literature ($_{\Lambda}B^{9}$, $_{\Lambda}C^{10}$, $_{\Lambda}O^{17}$, $_{\Lambda}O^{18}$, and $_{\Lambda}F^{20}$). (tr-auth)

12927 POLARIZATION AND SPIN EFFECTS IN THE THEORY OF SYNCHROTRON RADIATION. A. A. Sokolov and I. M. Ternov (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 153: 1052-4(Dec. 11, 1963). (In Russian)

In the classical approximation 7/8 of the total synchrotron radiation is σ-polarized (electric vector of the radiation along the radius of the electron orbit) and 1/8 is π-polarized (electric vector almost perpendicular to the plane of the electron orbit). The effects of polarization and spin of the electron were found by using the normalized Dirac equations for the motion of an electron in a constant homogeneous magnetic field, considering the cases where the electron spin vector is parallel to either the electron motion or the magnetic field. The intensities of the radiation components, depending on whether the spin vectors before and after the emission are parallel (p) or antiparallel (a), were found to be $W_{\sigma a}/W_c = \xi^2/18$; $W_{\sigma p}/W_c = 0.875 - \xi\,(3.61 - \zeta) + \xi^2\,(18.6 + 8.84\,\zeta) + \ldots$; $W_{\pi a}/W_c = 1.28\,\xi^2\,(1 + 0.989\,\zeta)$; and $W_{\pi p}/W_c = 0.125 - 0.361\xi + 1.389\xi^2 + \ldots$; where $W_c = (2/3)\,(e^2c/R^2)\,(E/m_0c^2)^4$, $\xi = (3/2)\,(h/2\,\pi mcR)\,(E/m_0c^2)^2$, and $\zeta = 1$ if the initial spin is parallel with the magnetic field, and $\zeta = -1$ if it is antiparallel. It is shown that at steady state 95% of the electron spins would be antiparallel to the magnetic field if certain counteracting factors are neglected. (TTT)

12928 ELEMENTARY PARTICLES AND RESONANCES. Tibor Nagy (Loránd Eötvös Univ., Budapest). Fiz. Szemle, 13: 201-9(July 1963). (In Hungarian)

Since the beginning of the 1930's, the number of the so-called elementary particles has increased rapidly; evidence of their existence could be obtained in most cases only indirectly, by means of difficult experiments, supported by daring theories. The first of the theories postulating new particles was developed by Dirac, followed by Fermi who developed the theory of weak interactions in β decay. R. Hofstadter's electron-scattering experiment is reviewed in this context. The problem of whether π mesons originated from the decay of a single particle or were formed independently from each other may be solved by determining the effective mass distribution. The existence of similar resonances was considered also by Fermi and his coworkers in 1952; they noted that the scattering cross section of π mesons on nucleons increases considerably if the energy of the π meson falls between 100 and 200 Mev. It was later found that the actual resonance is at about 195 Mev; similar resonances were also found at higher energies in the meson (π)–nucleon scattering. These phenomena were explained by assuming a metastable system. There is no conservation law involving quantum numbers and mass ratios which would forbid the rapid decay of resonances. The Sakata model and the Regge pole theory are reviewed in this context. (TTT)

12929 THE POLARIZED NEUTRON AS A RESEARCH TOOL IN NUCLEAR PHYSICS. István Lovas (Loránd Eötvös Univ., Budapest). Fiz. Szemle, 13: 209-16(July 1963). (In Hungarian)

It was previously discovered that neutrons may be polarized, assuring that the direction of the spin of the particles in a beam is not completely disordered. Polarized neutrons are used in 3 fields of research: nuclear spectroscopy; weak interactions; and time invariance of strong interactions. Nuclear spectroscopy involves the bombardment of nuclei with polarized neutrons, determining the spins of the excited states and the multipolarity of the γ transitions on the basis of the radiation subsequent to capture. Most of the earlier work was carried out with polarized slow neutrons; it should be kept in mind, however, that there are nuclear reactions, such as the (d,n) reaction, yielding high-energy polarized neutrons which may also be used for this type of investigations. (Review article, 14 references). (TTT)

12930 NONLOCALITY AND DISSYMMETRY OF ELECTRON-NEUTRINO INTERACTIONS IN THE Ke_3 MODE. C. Chahine (Laboratoire de Physique Atomique et Moléculaire, Paris and Laboratoire de Synthese Atomique, Ivry, France) and B. Jouvet. J. Phys., 24: 732-6 (Oct. 1963). (In French)

The possibility of nonlocal interactions symmetrical or asymmetrical in the electron and neutrino fields was considered and their effects in the Ke_3 mode were studied. The use of a $p_0\,q_0$ diagram (p_0 and q_0 being the energies of

the electron and the neutrino) was found to be suitable for testing possible nonlocalities and asymmetries of $e-\nu$ interactions and permits determination if the coupling is essentially vector, or scalar, or tensor. An asymmetry of the density of probability in $p_0\, q_0$ means a violation of the V(A) theory with local $e-\nu$ coupling, which results either from a nonlocal V(A) $e-\nu$ coupling or from the simultaneous existence of the S and T couplings (which can be local or not). The experiment of Luers et al., which was analyzed indicated that the coupling is essentially V(A) and showed an asymmetry in $p_0\, q_0$. The probability that the observed spectrum, resulting from a V(A) theory, with local $e-\nu$ current has this asymmetry is only 5%. (auth)

12931 STUDY OF THE STABILITY OF THE MOTION OF RADIATING ELECTRONS BY LINEAR APPROXIMATION. APPLICATION TO THE STORAGE RING. Francis Fer (Laboratoire Joliot-Curie de Physique Nucléaire, Orsay, France). J. Phys., 24: 746-52(Oct. 1963). (In French)

Stability was investigated on the basis of the Lorentz-Abraham equation of motion for the radiating electron. The equations of oscillations were derived for an arbitrary electromagnetic field, then particularized to a symmetry plane field. Calculations were made of damping factors due to the radiation loss. This calculation needed some expansion with respect to the radiating term, the validity of which is discussed. The calculation showed there is a phenomenon of destabilization of the phase oscillation due to the radiation loss, which is an effect only at very high energy. (auth)

12932 INTENSITY EFFECTS IN COMPTON SCATTERING. I. I. Goldman (Physical Inst. of the State Committee on the Use of Atomic Energy, Erevan, USSR). Phys. Letters, 8: 103-6(Jan. 15, 1964).

The Klein-Nishina formula for the Compton effect at high photon densities is studied in relation to obtaining hard gammas by the reflection of laser beams from relativistic electrons. The cross sections for two-photon absorption and emission of a hard photon are found. (R.E.U.)

12933 INELASTIC PROTON-PROTON SCATTERING AND NUCLEON ISOBAR PRODUCTION. G. Cocconi, E. Lillethun, J. P. Scanlon, C. A. Stahlbrandt, C. C. Ting, J. Walters, and A. M. Wetherell (CERN, Geneva). Phys. Letters, 8: 134-7(Jan. 15, 1964).

Targets of CH_2 and C were bombarded with 3.6- to 11.8-Bev/c protons at a fixed laboratory angle, and the momentum spectra of resulting protons are discussed in terms of $p + p \rightarrow N + N^*$ and $N^* \rightarrow N +$ pions processes. The production cross section of this nucleon isobar is investigated. (R.E.U.)

12934 PION-NUCLEON INTERACTIONS BETWEEN $T_{lab} = 300$ AND $T_{lab} = 700$ Mev. P. Bareyre (Centre d'Etudes Nucléaires, Saclay, France), C. Bricman, G. Valladas, G. Villet, J. Bizard, and J. Seguinot. Phys. Letters, 8: 137-41(Jan. 15, 1964).

It is shown that evidence for a π-N system (1400 Mev) exists in the π-p cross section for the $T = 1/2$ state and in the mass spectrum of the π^--p system in the final state of the $\pi^- + p \rightarrow \pi^+ + \pi^- + \pi^- + p$ reaction at $E_\pi = 2$ Bev. 30 references. (R.E.U.)

12935 BROKEN SYMMETRY AND RESONANCE POLES. S. C. Frautschi (California Inst. of Tech., Pasadena). Phys. Letters, 8: 141-3(Jan. 15, 1964).

Important deviations from the usual electromagnetic mass shifts between members of an isospin multiplet that occur because of a channel opening for one member of the multiplet are reviewed. In the splitting of SU(3) multiplets, the $P_{\frac{3}{2}}$ decuplet, including the unstable N_3^*, Y_1^*, and $\Xi_{\frac{1}{2}}^*$, and the stable Ω^- are studied. The mirror nuclei C^{13} and N^{13} are used to study electromagnetic mass shifts. (R.E.U.)

12936 CONNECTION BETWEEN PRODUCTION MECHANISM AND DECAY OF UNSTABLE PARTICLES: $KN \rightarrow K^*N$. K. Gottfried and J. D. Jackson (CERN, Geneva). Phys. Letters, 8: 144-6(Jan. 15, 1964).

The decay distribution of K^* and angular dependence of the production cross section were studied for the $K^+ + p$ reaction at $E_K = 3$ Bev/c giving the 3-body final state $K^0\pi^+p$. A direct relation between the spin-space density matrix of the unstable particle and the helicity amplitudes in the t channel is obtained. (R.E.U.)

12937 THREE-PION DECAYS OF UNSTABLE PARTICLES. Charles Zemach (Univ. of California, Berkeley). Phys. Rev., 133: B1201-20(Mar. 9, 1964).

The properties of particles of arbitrary spin and parity that decay into three pseudoscalar mesons are surveyed, with primary attention to 3π decays, in order to find efficient means of detecting such particles. Among the topics considered are the general forms of amplitudes subject to invariance and symmetry requirements, the regions of vanishing density in the Dalitz plot, branching ratios, angular correlations among vectors normal to and lying in the production and decay planes, and special decay modes through two-particle resonances. The angular correlations are discussed in detail for processes independent of the intrinsic spin of the production particles, as is appropriate in coherent nuclear processes, and a framework of analysis is provided for more complex problems. A complete characterization of $K \rightarrow 3\pi$ decays is given in terms of ΔI rules and final-state isospin. The suggestion is made that a second pion, with the same quantum numbers as the ordinary pion, should be found at an energy less than 2 Bev. This prediction is based on the possibility that the pion is primarily a nucleon-antinucleon bound S state and that the force of binding is therefore so strong that it should produce more than one bound S state. (auth)

12938 OPTICAL THEOREM AND OFF-DIAGONAL ELEMENTS OF THE T MATRIX. Leslie L. Foldy (CERN, Geneva and Case Inst. of Tech., Cleveland). Phys. Rev., 133: B1221-3(Mar. 9, 1964).

The optical theorem requires that the anti-Hermitian part of the T matrix have positive diagonal elements in any representation. The condition for this is that the anti-Hermitian part be a positive Hermitian matrix; this imposes restrictions in the form of inequalities, which involve off-diagonal as well as diagonal elements of the matrix in any particular representation. Specific results are derived for spin-flip amplitudes in the case where particles have spins $(\frac{1}{2},\frac{1}{2})$, $(\frac{1}{2},1)$, and $(1,1)$. Application to reaction amplitudes is also briefly discussed. (auth)

12939 PERTURBATION-THEORETICAL INTEGRAL REPRESENTATION AND THE HIGH-ENERGY BEHAVIOR OF THE SCATTERING AMPLITUDE. [PART] II. Noboru Nakanishi (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 133: B1224-31(Mar. 9, 1964). (BNL-7473)

It is established with almost complete generality by means of the perturbation-theoretical integral representation that the high-energy behavior of the exact scattering amplitude for spinless particles is closely related to the continued partial-wave Bethe-Salpeter equation, namely, the latter determines the generalized Regge trajectory equation. The Regge behavior is derived for the exact scattering amplitude of two identical neutral spinless particles. (auth)

12940 COMPLEX PROPAGATORS IN PERTURBATION THEORY. I. J. R. Aitchison (Brookhaven National Lab., Upton, N. Y.) and C. Kacser. Phys. Rev., 133: B1239-57(Mar. 9, 1964). (BNL-7392)

A method is given for studying the analytic properties of an arbitrary Feynman graph F, in which a full two-particle propagator G is inserted between one pair of points. Three special graphs are treated in detail: the two-particle amplitude itself, with two- and three-particle intermediate states, and the triangle graph. When G has a resonance, a possible approximation for F is to replace G by a complex pole, obtaining thereby a new graph f in which one internal particle has a complex mass. It is shown that, although the singularities of F and f are in general different, this approximation is appropriate for calculating enhancement effects due to singularities of F, near the physical region, associated with the resonance. For the cases considered, the ranges of the external variables for which such effects will occur, are predicted and it is shown how to calculate them explicitly. (auth)

12941 LOGARITHMIC SINGULARITIES IN PROCESSES WITH TWO FINAL-STATE INTERACTIONS. I. J. R. Aitchison (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 133: B1257-66(Mar. 9, 1964). (BNL-7377)

The effects of logarithmic singularities in rescattering processes are investigated. The reaction $\pi N \to \pi\pi N$ is considered, but treated purely as an S-wave, spinless model. A particular triangle graph is analyzed in detail; it contains as an intermediate state the (3,3) nucleon isobar I, which is described as a spinless particle of complex mass. The graph is calculated from a dispersion relation as a function of the mass s of the two pions in the final state, for low values of the over-all c.m. system energy W. The relation is then analytically continued in W. For a narrow range in W, an enhancement of the square of the amplitude is found near $s = 4$ (the pion mass is unity). The analogous enhancement also appears in the W channel near $W = I + 1$, for a small range of s only, near $s = 4$. The prominence of the effect depends on the width of I, being closely connected with the nearness to the physical region of one of the two logarithmic singularities (anomalous thresholds) of the graph; this distance increases sharply with the isobar width. The positions of the singularities are interpreted as the phase-space limits for the simultaneous production of states with mass s and I. The conclusion is that such a double excitation process leads to an enhancement of the triangle amplitude only if, in general, s and I fall in certain narrow ranges. The implications of this result for models of the higher resonances in the elastic channel ($\pi N \to \pi N$) are briefly discussed. (auth)

12942 MUONIC-DECAY BRANCHING RATIO OF THE LAMBDA HYPERON. Anne Kernan (Univ. of California, Berkeley), Wilson M. Powell, Carl L. Sandler, William L. Knight, and F. Russell Stannard. Phys. Rev., 133: B1271-3 (Mar. 9, 1964). (UCRL-11034)

An estimate of $R_\mu \leq 4 \times 10^{-4}$ was obtained for the branching ratio $R_\mu = \Gamma(\Lambda \to p\mu^-\bar{\nu})/[\Gamma(\Lambda \to p\pi^-) + \Gamma(\Lambda \to n\pi^0)]$. This result is based upon the observation of two examples of $\Lambda \to p\mu^-\bar{\nu}$ decay in an effective sample of 19,700 lambdas. The probability that the two events were due to processes other than Λ_μ decay could not be ruled out, so that the experiment gives an upper limit for R_μ. The lambdas were produced by K^- mesons interacting in a heavy-liquid bubble chamber, filled with a $CF_3Br-C_3H_8$ mixture. (auth)

12943 BETHE-SALPETER EQUATION FOR TRIPLET AMPLITUDE IN INTERMEDIATE-VECTOR-BOSON THEORY OF WEAK INTERACTIONS. K. Bardakci, M. Bolsterli, and H. Suura (Univ. of Minnesota, Minneapolis). Phys. Rev., 133: B1273-5(Mar. 9, 1964).

The Bethe-Salpeter equation for the triplet amplitude in the intermediate-vector-boson theory of weak interactions is shown to have a unique solution in configuration space; the solution has an essential singularity at the light cone, and does not have a Fourier transform. If the neutrino mass is zero, there exists a prescription that regularizes the amplitude to zero on the mass shell. (auth)

12944 K_2^0 DECAY. D. Luers, I. S. Mittra, W. J. Willis, and S. S. Yamamoto (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 133: B1276-89(Mar. 9, 1964). (BNL-7356)

A sample of 479 K_2^0 decays in a 20-in. hydrogen bubble chamber was obtained. Of these, 153 are identified as $K_2^0 \to (\pi^+e^-\nu)$ decay. The validity of CP invariance is suggested by the upper limit of 1.5% placed on the fraction of all K_2^0 decays that result in two charged pions; and by the ratio $(\pi^+e^-\nu)/(\pi^-e^+\nu) = 0.99 \pm 0.16$. The $(\pi^\pm e^\mp \nu)$ decay is found to proceed by the vector interaction, with an approximately constant form factor. The ratio $K\mu_3^0/K_{e3}^0 = 0.73 \pm 0.15$ implies that the ratio of the two form factors appearing in $K\mu_3$ decay f_-/f_+ is consistent with zero. The fraction of visible K_2^0 decays that result in $(\pi^+\pi^-\pi^0)$ is 0.157 ± 0.03. The prediction obtained by using the $\Delta I = \frac{1}{2}$ currents is 0.152 ± 0.017. The data may be combined with other experiments to provide additional tests of the $\Delta I = \frac{1}{2}$ rule. (auth)

12945 PHENOMENOLOGICAL TREATMENT OF THE ρ TRAJECTORY. Akbar Ahmadzadeh and Ismail A. Sakmar (Univ. of California, Berkeley). Phys. Rev., 133: B1290-2(Mar. 9, 1964). (UCRL-11032)

A phenomenological method is applied to the ρ trajectory. It is argued that once the intercept is known, the method is expected to give reliable information about the trajectory in the region of interest for high-energy scattering. Solutions for different values of the intercept ranging from 0.3 to 0.8 are given. From certain general requirements the higher intercepts seem to be favored. (auth)

12946 INTERRELATIONS AMONG DISSYMMETRIES IN SU_3 SUPERMULTIPLETS. Pekka Tarjanne and R. E. Cutkosky (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 133: B1292-8(Mar. 9, 1964).

The mass splittings within the (unitary) supermultiplets of the strongly-interacting particles are studied in the octuplet model of SU_3 symmetry. Using arguments based on the requirement of dynamical self-consistency, qualitative properties of the first-order perturbations in masses and coupling constants are studied in the ladder approximation. Further evidence for the origin of the particular type of dissymmetry leading to the Gell-Mann-Okubo mass formula and to isotopic spin symmetry is gotten through the relations between the dynamical effects in different supermultiplets. The observed mass splittings in the pseudoscalar meson, vector meson, and the $\frac{1}{2}(+)$ baryon octuplets, as well as in the $\frac{3}{2}(+)$ baryon decuplet, are compatible with the general features expected from first-order perturbations. Some higher order perturbations in the $\frac{3}{2}(+)$ decuplet are also discussed. (auth)

12947 HIGHER ORDER LEPTONIC WEAK INTERACTIONS. Yih Pwu (Univ. of Pennsylvania, Philadelphia), and Tai Tsun Wu. Phys. Rev., 133: B1299-1305(Mar. 9, 1964).

Higher order leptonic weak interactions as mediated by a charged intermediate boson are studied on the basis of summing the leading terms in perturbation theory. An important question is whether it is consistent to assume that

such a procedure is meaningful and leads to finite results. This is indeed the case for the uncrossed ladder graphs, as shown by Feinberg and Pais. Here an attempt is made to study all higher order graphs. The regularization procedure adopted is the ξ-limiting formalism of Lee and Yang, and the leading terms taken into account are those that, for a given power of the coupling constant, contain the highest power of ξ^{-1} and also the highest possible power of ln ξ consistent with this maximum power of ξ^{-1}. The sum is determined by a comparison with the electrodynamics of vector mesons on the assumption that it is meaningful to sum the leading terms in both theories. It is then found that, for four-fermion allowed processes at energies much below 300 Bev, no inconsistencies are found and the conventional g^2 should be replaced by $\frac{5}{16}g^2$. (auth)

12948 MONTE CARLO CALCULATIONS RELATED TO THE ANALYSIS OF ULTRAHIGH-ENERGY NUCLEON–NUCLEON INTERACTIONS. R. D. Settles and R. W. Huggett (Louisiana State Univ., Baton Rouge). Phys. Rev., 133: B1305-17(Mar. 9, 1964).

The Monte Carlo method is applied to an investigation of angular-distribution parameters currently in use in studies of ultrahigh-energy nuclear interactions. Specifically, center-of-mass system properties of meson showers having a total multiplicity of 16 and corresponding to nucleon–nucleon collisions at 3×10^{12} ev are calculated using the Monte Carlo method and employing input information based largely on experimentally determined average properties of ultrahigh-energy nuclear interactions. The resulting meson showers conserve energy and momentum, the angular distributions on the average possess forward-backward symmetry in the center-of-mass system, and the produced particles of each shower possess only those correlations introduced by energy-momentum conservation. After making an exact transformation of the showers to the laboratory system, some conventional analysis procedures are carried out with the resulting Monte Carlo jets using parameters calculated from the angular distributions of the charged particles. The results give insight into the sensitivity of the parameters to approximations used in the interpretation of the parameters and indicate how well, on the average as well as for individual jets, a parameter $Y(\theta)$ is a measure of the physical quantity y which the parameter is expected to represent. The parameters are studied using the means and standard deviations of their $\log[Y(\theta)/y]$ distributions. The Castagnoli energy is found, rather independently of the details of the Monte Carlo calculations, to be an overestimate of the energy of a jet by an average factor of about 1.8 (antilogarithm of the mean), with a factor 2.3 (antilogarithm of the standard deviation) defining the approximate 68% confidence interval for statistical fluctuations about this average factor in the case of individual jets. Seven other parameters are examined and are found to be generally more sensitive to the details of the Monte Carlo calculations. The factor defining the approximate 68% confidence interval for statistical fluctuations of individual $Y(\theta)/y$ values about the average factor ranges from 1.5 to 3.1 for these other parameters. An application of the $(x-\langle x\rangle)/\sigma$ analysis of the Krakow-Warsaw group indicates that, at least for the jet models considered, fluctuations will not result in spurious two-center effects being indicated by the analysis. (auth)

12949 FEYNMAN RULES FOR ANY SPIN. Steven Weinberg (Univ. of California, Berkeley). Phys. Rev., 133: B1318-32(Mar. 9, 1964).

The explicit Feynman rules are given for massive particles of any spin j, in both a $2j + 1$-component and a $2(2j + 1)$-component formalism. The propagators involve matrices that transform like symmetric traceless tensors of rank 2j; they are the natural generalizations of the 2×2 four-vector σ^μ and 4×4 four-vector γ^μ for $j = \frac{1}{2}$. The calculation uses field theory, but only as a convenient instrument for the construction of a Lorentz-invariant S matrix. This approach is also used to prove the spin-statistics theorem, crossing symmetry, and to discuss T, C, and P. (auth)

12950 STUDY OF THE DECAY $\pi \to e + \nu$. E. Di Capua, R. Garland, L. Pondrom, and A. Strelzoff (Columbia Univ., New York). Phys. Rev., 133: B1333-40(Mar. 9, 1964).

A large NaI(Tl) crystal was used to measure the $\pi \to e/\pi \to \mu$ branching ratio. From a sample of 10,800 $\pi \to e$ decay electrons the branching ratio was found to be $R = (1.247 \pm 0.028) \times 10^{-4}$ in agreement with a universal theory for $(e\nu)$ and $(\mu\nu)$ weak couplings. (auth)

12951 FAIRLY LOW-ENERGY PION-PION SCATTERING. [PART] II. Alvin M. Saperstein and Jack L. Uretsky (Argonne National Lab., Ill.). Phys. Rev., 133: B1340-3(Mar. 9, 1964).

The pion-pion calculation of Smith and Uretsky was extended by including the third-order perturbation theoretic terms for the discontinuity across the left-hand cut in the complex energy plane. The right-hand cut is still given by elastic unitarity. Numerical calculations for the S- and P-wave amplitudes show that the S waves are not much different than they were in the second-order calculation. The P-wave amplitude is substantially modified, and the trends are such as to make it plausible that a fourth-order calculation could reproduce the ρ resonance. It was also interesting to find that the P-wave interaction can be strongly attractive (to this order) only if the S-wave interactions are repulsive. (auth)

12952 DETERMINATION OF THE PROTON-PROTON $^1S_0$ SHAPE PARAMETER. H. Pierre Noyes (Stanford Univ., Calif.). Phys. Rev. Letters, 12: 171-6(Feb. 17, 1964).

It is shown that data on p-p scattering near the interference minimum at 0.3825 Mev and on the p-p differential cross sections measured at 1.397, 1.855, 2.425, and 3.037 Mev can be analyzed to yield a precise value of the shape parameter. 29 references. (R.E.U.)

12953 UNITARY SYMMETRY AND THE SIGN OF $(K_1^0 - K_2^0)$ MASS DIFFERENCE IN POLE APPROXIMATION. S. N. Biswas and S. K. Bose (Tate Inst. of Fundamental Research, Bombay). Phys. Rev. Letters, 12: 176-8 (Feb. 17, 1964).

The sign of the mass difference $(K_1^0 - K_2^0)$ is calculated using a model in which the mass difference arises from the one-particle "pole" terms in the $K_{1,2}^0$ propagator and in which the relevant two-point coupling constants that occur in the expression for the mass difference can be related by means of the octet version of the unitary symmetry scheme due to Gell-Mann and Ne'eman. As consequences of the model, $K^+ \to \pi^+ + e^+ + e^-$, $K_2^0 \to 2\gamma$, and $\Delta T = \frac{1}{2}$ violation in $K_2^0 \to \pi^+ + \pi^- + \pi^0$ decay are discussed. (R.E.U.)

12954 ARE THE f^0 AND B MESONS TWO DECAY MODES OF THE SAME PARTICLE? William R. Frazier, Sharashchandra H. Patil, and Nguyen-huu Xuong (Univ. of California, San Diego, Calif.). Phys. Rev. Letters, 12: 178-82(Feb. 17, 1964).

The implications of a necessary assignment of $J^\pi = 1^-$ to the B meson in order to correlate it to the f^0 meson are discussed in terms of angular distributions and branching

ratios in f decay and one-pion and one-omega exchange in B production. 15 references. (R.E.U.)

12955 POSITRON-PROTON SCATTERING. A. Browman, F. Liu, and C. Schaerf (Stanford Univ., Calif.). Phys. Rev. Letters, 12: 183-4(Feb. 17, 1964).

The ratios of the cross sections for elastic electron-proton and positron-proton scattering at momentum transfers of 3.5 and 19.5 F^{-2} were measured. (R.E.U.)

12956 A SUGGESTION OF EXPERIMENT TO DETECT THE p-RESONANCE IN $\pi-\pi$ SCATTERING. Tso-hsiu Ho and Kuang-chao Chou. Wu Li Hsueh Pao, 17: 133-4(Mar. 1961). (In Chinese)

An experiment designed to detect the p-resonance in $\pi-\pi$ scattering process is suggested. (auth)

12957 FOUR BODY DECAY OF Σ IN A COMPOSITE MODEL. Li-ning Chang, In An, Ting-gin Chen, and Yuan-beng Dai. Wu Li Hsueh Pao, 18: 264-71(Mar. 1962). (In Chinese)

The life time of Σ particles in a four body decay in composite model is calculated by making use of the known properties of the Λ decay; the result is $\tau \cong 50\ \tau_{\Lambda\to p+e+\bar{\nu}}$. Such a life time is also calculated by using ordinary models where the relative parities of Σ and Λ are even. Results of calculations show that the first life time is about 50 times smaller. (auth)

12958 ON THE ELECTROMAGNETIC FORM FACTOR OF THE K_0 MESON. Hsuch-hui Kung. Wu Li Hsueh Pao, 18: 272-5(May 1962). (In Chinese)

12959 ON K^+-N ELASTIC SCATTERING. Liau-fu Lo and Sin Shue. Wu Li Hsueh Pao, 18: 291-7(June 1962). (In Chinese)

By means of the Tamm-Dancoff approximation, the K^+-N elastic scattering problems are solved. Phase shifts and cross section at five energies below 400 Mev were calculated. The numerical results are compared with previous work. In calculation, the nucleon recoil effects are considered, which may give better energy dependence of K^+-p scattering above 250–300 Mev. The different possibilities of K–Y relative parities were also considered. The results favor odd parity but the opposite parities of Λ and Σ particles also fit the K^+-p scattering data. However, the two cases are not in agreement with the experiment in analyzing the K^+-n scattering. (auth)

12960 THE HIGH ENERGY NUCLEON-NUCLEON SCATTERING IN THE STRIP APPROXIMATION. Shih Chen and Yuan-ben Dai. Wu Li Hsueh Pao, 18: 321-3 (June 1962). (In Chinese)

12961 SOME STUDIES IN AXIOMETRIC THEORY OF FIELDS AND HAMILTONIAN DYNAMICS OF INTERACTING RELATIVISTIC PARTICLES. Raghunath Acharya. Thesis, Rochester, N. Y., Univ. of Rochester, 1963. 102p.

Several general theorems in axiomatic field theory are proved. Fields A(x), B(x), etc. are considered, which obey a commutation relation of the type: $[A(x), B(y)] = F(x-y)$, where $F(x-y)$ vanishes for space-like separations but is not in general a c-number. Proofs are based on certain assumptions such as irreducibility of the fields and their local property. The Jacobi identity is used. In part 2, fields are ignored altogether and attempts to construct non-trivial, relativistically invariant systems of interacting particles are described. The work is in terms of Hamiltonians and demonstrates the equivalence of theories of this type to purely dispersion-type theories. In particular, a Hamiltonian model is constructed, which is relativistically invariant and which is equivalent to the model field theory of Zachariasen. The final part is reserved for the discussion and exposition of the concept of "elementary" and "composite" particles. In particular, it is shown that the $Z = 0$ limit of an "elementary" particle theory, where Z is the wave-function renormalization constant of the particle in question, leads to a theory in which the particle can be regarded as "composite" or a bound state. (Dissertation Abstr.)

12962 RESONANCE MODEL FOR PHOTOPRODUCTION OF K-MESONS ON NUCLEONS. Shigeo Hatsukade. Thesis, Rochester, N. Y., Univ. of Rochester, 1963. 105p.

A theoretical analysis of the photoproduction of K mesons on nucleons based on dispersion relations is presented. On the supposition that, among the various intermediate states in the 3 related channels, only the single particle states and resonant states make appreciable contributions, an approximate one-dimensional dispersion relation of the Cini-Fubini type is assumed for the invariant amplitudes of this process. The resonant states that are taken into account are the following: the 3 pion-nucleon resonances, the pion-kaon resonance, and the 3 pion-hyperon resonances. By the conservation of angular momentum and parity, only certain multipole amplitudes determined by the spin and parity of the resonances contribute to the spectral functions, and for these non-vanishing multipole amplitudes the Breit-Wigner formula is assumed. This theory contains, besides the usual coupling constants of single particles, a product of partial widths for each resonance as a parameter. For all but 3 of these parameters the values determined from experiments other than kaon-photoproduction experiments are used, and the remaining 3 are adjusted as free parameters. A reasonable agreement with experimental data was obtained taking spin 1 for the $K\pi$ resonance and taking –1.5 nuclear magneton for the Λ-hyperon magnetic moment. (Dissertation Abstr.)

12963 PHOTOPRODUCTION OF NEUTRAL PIONS FROM HYDROGEN NEAR ZERO DEGREES. Virgil Lee Highland. Thesis, Ithaca, N. Y., Cornell Univ., 1963. 100p.

By detecting the 2 decay photons of the pion with Pb-glass Cerenkov counters, the differential cross section for the photoproduction of π^0 mesons from H near 0° has been measured. The energy range covered was 290 to 700 Mev. Good energy resolution was attained by making a subtraction of yields obtained with 2 different values of the opening angle between the photons. The results fit smoothly onto the usual type of angular distribution, given approximately by $2 + 3\sin^2\theta$. The results are in reasonable agreement with the theoretical angular distributions of Gourdin and Salin, but disagree with that of De Tollis and Verganelakis at 400 Mev. A least squares fit to the angular distributions of all the available data in the energy range 295 to 950 Mev was made. A detailed discussion of an analytic calculation of the detection efficiency and angular resolution of the 2-photon detection method is presented. (Dissertation Abstr.)

12964 THE DECAY OF BOUND MUONS IN ELEMENTS OF INTERMEDIATE Z. Richard John Jacob. Thesis, Salt Lake City, Univ. of Utah, 1963. 83p.

The bound-muon decay rate, λ_d, was measured for Mn, As, Cd, and I by observing the time distribution of decay electrons from positive and negative cosmic-ray muons. Al reference targets were used to avoid the necessity of knowing the precise abundance ratio of positive to negative cosmic-ray muons. The decay electrons were detected in a totally absorbing CCl_4 Cerenkov counter. The data were

corrected for contamination by muon capture events, and for differences in the positive and negative decay electron spectra. An attempt was made to explain the observed positive decay electron spectra by applying degradations to the theoretical Michel spectrum. The ratio λ_d/λ_0, of bound to free decay rates was found to be 0.91 ± 0.06 for Mn, 1.04 ± 0.07 for As, 0.98 ± 0.09 for Cd, and 0.86 ± 0.09 for I. These results are in agreement with recent theoretical predictions. The value for As, however, will not be finalized until a correct negative muon mean-life is determined. (Dissertation Abstr.)

12965 ON THE STRUCTURE OF WEAK INTERACTIONS. Jan Simon Nilsson. Thesis, Rochester, N. Y., Univ. of Rochester, 1963. 102p.

Research that has been performed on the problem of a possible structure for the weak interactions is surveyed. Some particular processes, which could possibly reveal effects of such a structure, are considered. Since present experimental technique can not detect deviations from the theoretical predictions based on first-order calculations, processes, which can only occur if higher order effects are essential, must be found. Such a process, the decay $\mu \rightarrow 3e$, is investigated in detail. The divergence difficulties in the conventional theory are taken as evidence for a breakdown of the theory at sufficiently small distances, represented by a sharp cut off introduced in the theory. An upper limit of 50 to 100 Bev for this cut-off energy seems to be compatible with all forbidden (higher order) processes investigated so far. The result of this calculation suggests a cut-off of the same order of magnitude. One piece of information clearly indicates that higher order effects in weak interactions are essential. This is the transition $K^0 \rightleftharpoons \bar{K}^0$, which manifests itself by a mass splitting for the 2 physical neutral K-mesons, namely K_1^0 and K_2^0. It is found that the measured mass difference implies a cut off of the order of a few Bev, which is about an order of magnitude smaller than the cut off obtained for purely leptonic processes. The structure of weak interactions may also be studied by means of very-high-energy experiments. It is found that even in the multi-Bev region cross sections for possible forbidden processes are probably beyond what one can detect at present or in a near future. The coherent process $\gamma + z \rightarrow \mu + e + z$ is discussed. (M.P.G.)

12966 AN INVESTIGATION OF PION-PROTON INTERACTIONS AT HIGH ENERGIES. Chao Chung Ting. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1963, 64p.

The pion-proton differential cross sections were measured with a set of spark chambers and triggering scintillation counters at the incident negative-pion momenta of 3.15, 4.13, and 4.95 Bev/c and also for the incident positive-pion momentum of 2.92 Bev/c. The data taken in this experiment show agreement with the Regge Pole theory in that the diffraction cross section is exponential and agrees with the p-p data at about the same momentum range. But they do not agree with the Regge Pole prediction in that the width of the diffraction peak shrinks with increasing incident momenta. The data taken in this and other experiments for the π^-p scattering above 3 Bev/c show that there is no shrinkage in the π^-p diffraction peak. Large angle scattering data were also analyzed with the upper limit of the differential cross section at the backward region (approximately $0 > \cos^* \theta_\pi > -0.95$) less than 10 μb/st at our momentum range. (Dissertation Abstr.)

12967 VOPROSY FIZIKI ELEMENTARNYKH CHASTITS. (Problems in Physics of Elementary Particles). A. I. Alikhamyana, ed. Erivan, Publishing House of the Academy of Sciences, 1963. 600p.

Lectures are presented on resonances in elementary particle systems, high-energy interactions, weak interactions, nuclear theory, electromagnetic interactions, accelerators, and experimental apparatus. Determination of π-π cross sections, baryon isobars, the K* meson, η^0 decays, pion resonances, strong interaction symmetry, $\bar{K}N$ scattering and $\Sigma\pi$ resonances, scattering amplitudes, polology and Reggeology, p-p, π-p, and p-$\bar{p}$ scattering, collision kinematics, parity non-conservation and macroscopic rotation, K_2^0 decay, form factors, selection rules, three-particle interactions, electromagnetic structure of nucleons, pair production in crystals, and the Compton effect on moving electrons are discussed. Accelerators, spark chambers, and bubble chambers for use in elementary particle experiments are also considered. Thirty-eight papers are included. (C.E.S.)

Field Theory and Quantum Mechanics

12968 (JINR-P-1443) ZAMECHANIYA K PROBLEME GEOMETRIZATSII SKALYARNOGO POLYA. (Note on the Problem of Geometrization of a Scalar Field). Milos Uhlir (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 10p.

Relativistic equations of motion of a classical point-particle in a scalar field are given, allowing geometric interpretation as equations of geodesics in a conformal-Euclidean Riemannian space. The equations can be transformed into the form of Hamilton-Lagrange or Hamilton-Jacobi. This allows wave equations of particles in an external scalar field. The theory leads to the conclusion that the mass of particles is not a constant, but a function of a scalar field in the equations of motion. (auth)

12969 (JINR-P-1483) OB USTRANENII RASKHODIMOSTEI V KRAZIPOTENTSIAL'NYKH URAVNENIYAKH. (On Removal of Divergencies in Quasipotential Equations). A. T. Filippov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 7p.

The divergences that appear in constructing the quasipotential equations in the field theory are investigated. A possibility of avoiding them is indicated, and the equations for the wave functions in the r-space are found. (auth)

12970 (JINR-P-1493) O POSTROENII KVAZIPOTENTSIAL'NYKH URAVNENII V TEORII POLYA. (On the Construction of Quasipotential Equations in Quantum Field Theory). A. T. Filippov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 9p.

The lowest approximations for the quasipotential equations in the $\lambda\phi^3$ and $\lambda\phi^4$ theories were studied. The applicability of Fredholm method in the $\lambda\phi^3$ theory is shown. However, this method is inapplicable to the $g\phi^4$ theory; in this case a special recipe is suggested to determine the singularities in the l plane. The found approximate expression for the local potential leads to the nonanalytical dependence on g. (auth)

12971 (NASA-TN-D-1985) RECIPROCITY IN QUANTUM MECHANICS. D. E. Bilhorn, L. L. Foldy, V. A. Madsen, R. M. Thaler, and W. Tobocman (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Aug. 1963. 23p.

A new derivation of the reciprocity theorem is given. The general invariance property of the hamiltonian that leads to symmetry of the Green's function for a quantum mechanical system is exhibited. It is found that reciprocity does not necessarily imply Hermiticity of the hamil-

tonian; the so-called optical model potential, for example, satisfies the reciprocity relations. The concept of reciprocity is then generalized to include a somewhat wider class of symmetry properties. Some properties of antiunitary transformations are discussed. (auth)

12972 (TID-20113) SINGULAR POTENTIALS AND PERATIZATION. [PART] I. N. N. Khuri (Columbia Univ., New York) and A. Pais (Rockefeller Inst., New York). [1963]. Contract AT(30-1)-1934. 21p.

The peratization concept in field theory is illustrated by treating scattering by singular repulsive power potentials in quantum theory. Singular potentials not of the power type are also discussed. (D.C.W.)

12973 DISCUSSION OF A NORMALIZED WKB-LIKE WAVE FUNCTION. W. Macke and P. Rennert (Technische Universität, Dresden). Ann. Physik (7), 12: 32-44(Oct. 1963). (In German)

An approximation method for calculation of the wave function of a particle in a given potential is discussed, which leads to a solution similar to the WKB (Wentzel, Kramers, and Brillouin) solution. In the first approximation an expression is obtained which corresponds to the improved WKB solution obtained by Langer. The method allows the physical assumptions, which lead to the WKB solution, to be recognized exactly. (tr-auth)

12974 ON THE QUANTUM MECHANICAL TREATMENT OF MANY-PARTICLE SYSTEMS IN WKB-SIMILAR APPROXIMATION. W. Macke and P. Rennert (Technische Universität, Dresden). Ann. Physik (7), 12: 84-105(Oct. 1963). (In German)

A WKB-similar approximation method considered previously for calculation of the wave function of a particle at a given potential was used for calculation of the density of a system of many independent particles in a common, given potential. A density expression was obtained from which, by operator-like evaluation, the density matrix was obtained. An explicit representation for density was derived, which possesses the same functional form for all potentials. In zero approximation the solution agreed with the Thomas-Fermi solution, in the first approximation the density fluctuations and the exponential decay were comprehended. Using a self-consistent-field method, particles with exchange effects could be treated. For the examples considered a good agreement with the exact process was obtained. (tr-auth)

12975 THEORY OF QUANTUM PLASMA. G. Kelbg (Universität, Rostock, Ger.). Ann. Physik (7), 12: 219-24 (Nov. 1963). (In German)

The quantum-statistical partial function of an N-particle system in the case of far-reaching intermolecular exchange effects was calculated. The process is applicable if the potential possesses Fourier transformation. By introduction of an effective potential, which depends on the temperature and the Planck quantum effect, it was possible to refer to the known classical equations and to draw up formulas for the free energy and the radial distribution function. In the case of a plasma in place of the Coulomb potential an irregular non-singular potential function enters in the vicinity of the zero point. Its amount at the zero point can be determined by the reciprocal value of the thermal wavelength. (tr-auth)

12976 FEYNMAN INTEGRALS AND THE SCHRÖDINGER EQUATIONS. Edward Nelson (Princeton Univ., N. J.). J. Math. Phys. (N. Y.), 5: 332-43(Mar. 1964).

Feynman integrals, in the context of the Schroedinger equation with a scalar potential, are defined by means of an analytic continuation in the mass parameter from the corresponding Wiener integrals. The method yields a new interpretation of highly singular attractive potentials in quantum mechanics. For the example of the attractive $1/r^2$ potential, this interpretation agrees with classical mechanics in the correspondence limit. (auth)

12977 REGGE POLES AND POTENTIALS WITH CORES. John W. Durso and Peter Signell (Pennsylvania State Univ., University Park). J. Math. Phys. (N. Y.), 5: 350-4(Mar. 1964).

The analytic behavior of the S matrix as a function of real momentum and complex angular momentum is examined for the case of nonrelativistic scattering by potentials with hard-core interiors. The presence of a hard core in a potential introduces a type of symmetry that, combined with unitarity, places restrictions upon the movement of the Regge poles and upon the allowable representations of the scattering amplitude. In particular, it is found that the Watson–Sommerfeld transform representation of the scattering amplitude is not valid. An alternate representation of the S function, more practical for such cases, is postulated and examined numerically. Numerical results are presented for the case when the hard core is replaced by a finite barrier added to a repulsive Yukawa potential interior. It is found that additional trajectories appear. The mechanism for producing the threshold behavior of the phase shifts is compared to that of the case where a hard core is not present. (auth)

12978 GENERALIZED ADIABATIC INVARIANCE. L. M. Garrido (Universidad, Barcelona). J. Math. Phys. (N. Y.), 5: 355-62(Mar. 1964).

The quantities that are adiabatic invariants of any desired order for a general slowly time-dependent hamiltonian are found. A quantity is found that is an adiabatic invariant to mth order for any hamiltonian that changes slowly in time, and that does not fulfill any special condition (its first time derivatives are not zero initially and finally). (auth)

12979 CONVERGENCE OF YUKAWA THEORIES WITH A FINITE NUMBER OF INTERACTING BOSON MODES. William M. Frank (Naval Ordnance Lab., Silver Spring, Md.). J. Math. Phys. (N. Y.), 5: 363-72(Mar. 1964).

Convergence of the perturbation expansion of the S matrix is demonstrated for a field theory where a quantized fermion field with regularized propagator interacts with a finite number of quantized boson modes. Conventional graphical techniques and combinatorial analysis are used to establish this result, derived earlier by Edwards, but not properly clarified. A zero radius of convergence is demonstrated for the theory where a Yukawa-type interaction takes place between one boson field interacting in only a finite number of modes with another boson field coupled to it bilinearly. The relation of this result to the convergence of infinite coupled mode theories is discussed. (auth)

12980 THE CONNECTION BETWEEN CONSERVATION LAWS AND LAWS OF MOTION IN AFFINE SPACES. Peter Havas (Lehigh Univ., Bethlehem, Penna.). J. Math. Phys. (N. Y.), 5: 373-82(Mar. 1964).

It was pointed out recently that for any theory describing matter as a collection of mass points in a metric space and subject to a covariant conservation law for a symmetric tensor density, the geodesic law of motion as well as the form of the tensor density follow from the conservation law alone, independent of any equations obeyed by the metric. This result is shown to be valid in any affine space, independent of any equations obeyed by the affine connection;

conversely, the geodesic law implies a conservation law for a singular symmetric tensor density. Similarly, the existence in any affine space of a covariant conservation law for a vector density describing a collection of point charges is shown to imply the constancy of charge, and the form of the vector density; conversely, the constancy of charge implies a conservation law for a singular vector density. Some applications of these results are presented. A discussion of the laws of motion for particles with an intrinsic dipole moment is presented. (auth)

12981 ENERGY SHARING AND EQUILIBRIUM FOR NONLINEAR SYSTEMS. Robert S. Northcote and Renfrey B. Potts (Univ. of Adelaide). J. Math. Phys. (N. Y.), 5: 383-98(Mar. 1964).

A study is made of a one-dimensional system of identical particles in which the forces between neighbors are linear. The system is nonlinear because it is assumed that collisions occur between adjacent particles, which each have an effective diameter $\underline{d}$. The energies E_i in the linear normal modes are computed numerically to show that energy is freely exchanged between all the modes in the system, as predicted by the theory. The time averages $\langle E_i \rangle$ of these energies show a strong tendency toward equipartition of energy among the modes. This is in distinct contrast to the computations of Ulam, Fermi, and Pasta, which showed that some nonlinear systems appear to be nonergodic. An equation of state and an expression for the total energy of the system as a function of thermodynamic coordinates are derived via statistical mechanics. Expected values for the pressure and temperature of the assembly may then be computed. A comparison of these with the numerical values of those variables arising from the computations shows that the nonlinear system approaches equilibrium. (auth)

12982 SOME EXACT RADIAL INTEGRALS FOR DIRAC–COULOMB FUNCTIONS. J. T. Reynolds, D. S. Onley, and L. C. Biedenharn (Duke Univ., Durham, N. C.). J. Math. Phys. (N. Y.), 5: 411-19(Mar. 1964).

The zero energy loss Dirac–Coulomb integrals are evaluated using the technique of contour integration. The expressions obtained have a closed analytic form, showing that these integrals are formally similar to the corresponding classical and nonrelativistic quantum mechanical zero energy loss integrals that also have exact elementary solutions. Application of the zero energy loss Dirac–Coulomb integrals occurs in inelastic electron scattering and similar problems. The investigation of the finite energy loss Dirac–Coulomb integrals requires a study of the zero energy loss integrals as a preliminary. (auth)

12983 THE COMPLETE HIGH-ENERGY BEHAVIOR OF LADDER DIAGRAMS IN PERTURBATION THEORY. J. C. Polkinghorne (Cambridge Univ., Eng.). J. Math. Phys. (N. Y.), 5: 431-?(Mar. 1964).

The Mellin-transform method for obtaining the high-energy behavior of Feynman integrals is modified and applied to the set of ladder diagrams. The complete set of terms of the form $s^{-1}(\ln s)^n$ is summed, and gives an equation for the trajectory function that is analogous to that obtained by Fredholm methods for a Yukawa potential. A perturbation expansion for $\alpha(t)$ valid for t large is given, and the threshold behavior investigated. The results confirm the reliability of the perturbation-theory method of investigation. They also exhibit directly the connection between high-energy behavior and the poles of the scattering amplitude. (auth)

12984 ANALYTIC CONTINUATION IN COMPLEX ANGULAR MOMENTUM AND INTEGRAL EQUATIONS. George Tiktopoulos (Princeton Univ., N. J.). Phys. Rev., 133: B1231-8(Mar. 9, 1964).

An attack is made on the problem of the analytic continuation in the angular momentum variable l of amplitudes defined by integral equations beyond the value of Rel at which the kernel ceases to be of the Schmidt type and the Fredholm theory cannot be applied. A general technique is developed and applied to the Yukawa potential case and to the ladder graph series in the φ^3 theory. In both cases meromorphy is established for Rel $> -\frac{5}{2}$ and a procedure is indicated for a stepwise continuation to the entire l plane. (auth)

12985 SCATTERING OF YANG-MILLS QUANTA. Edward A. Remler (Univ. of North Carolina, Chapel Hill). Phys. Rev., 133: B1267-70(Mar. 9, 1964).

Dirac spinor quanta interacting via a Yang-Mills field are considered and lowest order perturbation theoretic transition matrix elements are given for the elementary scattering processes. All expressions are invariant under the full gauge group. All processes exhibit infinite forward scattering as expected from the masslessness and charge of the Yang-Mills field quanta. A helicity conservation law holds when Yang-Mills quanta scatter each other. (auth)

12986 GAUGE INVARIANCE AND LOCALIZABILITY IN ELECTROMAGNETIC THEORY. L. J. Tassie (Australian National Univ., Canberra). Phys. Rev., 133: B1351(Mar. 9, 1964).

It is pointed out that there is no connection between gauge invariance and localizability in electromagnetic theory such as that discussed by Aharonov and Bohm. (auth)

12987 GENERALIZATION OF THE RUNGE-LENZ VECTOR IN THE PRESENCE OF AN ELECTRIC FIELD. Peter J. Redmond (Defense Research Corp., Santa Barbara, Calif.). Phys. Rev., 133: B1352-3(Mar. 9, 1964).

It is well known that the Kepler problem admits two vector constants of the motion, the angular momentum and the Runge-Lenz vector. A generalization of the Runge-Lenz vector is found when a uniform constant electric field is present. The component of this vector in the direction of the external field is a constant of the motion. (auth)

12988 REMARKS ON THE RELATIVISTIC KEPLER PROBLEM. II. APPROXIMATE DIRAC-COULOMB HAMILTONIAN POSSESSING TWO VECTOR INVARIANTS. L. C. Biedenharn and N. V. V. J. Swamy (Duke Univ., Durham, N. C.). Phys. Rev., 133: B1353(Mar. 9, 1964).

The Dirac-Coulomb hamiltonian is shown to contain a fine structure interaction that, when removed, defines a new hamiltonian differing from the Dirac-Coulomb hamiltonian in order $(\alpha Z)^2/|\kappa|$. The solutions of this new hamiltonian, as well as its complete set of invariant operators, are explicitly given. This symmetric hamiltonian possesses a larger symmetry group than the R_4 group structure of the nonrelativistic Coulomb hamiltonian. The simplicity of the complete orthonormal set of solutions of the symmetric hamiltonian lends itself to several useful applications that are briefly indicated. The relation between the solutions of this new hamiltonian and the Sommerfeld-Maue-Meixner-Furry wave functions is discussed. (auth)

12989 RELATIVISTIC WAVE MECHANICS. E. Corinaldesi and F. Sto Strocchi. From the Series in Physics. New York, Interscience Publishers, 1963. 318p. $12.00.

Wave functions, particles of spin zero, particles of spin one-half, and collision and radiation processes are considered. Lagrangian formalism, translation and rotation operators, particles in electromagnetic fields, spin operators, the Weyl and Dirac equations, time-dependent,

time-independent, and steady-state scattering, and emission and absorption of electromagnetic radiation are discussed. (C.E.S.)

12990 QUANTUM MECHANICS. David B. Beard. Boston, Allyn and Bacon, Inc., 1963. 318p. $9.75.

Physical consequences of a wave theory of material particles are investigated by an examination of the extreme, non-classical characteristics of abrupt changes in potential energy as a function of space. Black body radiation, Fourier analysis, diffraction and interference of photons and particles, Feynman path integrals, the Schroedinger equation, wave functions, the WKB approximation and Bohr-Sommerfeld quantum conditions, three-dimensional wave functions in spherical coordinates, perturbation theory, time-dependent perturbation theory, chemical resonance theory, spin, symmetry, parity, vector addition, and elastic scattering theory are discussed. (C.E.S.)

12991 SIMULTANEOUS OBSERVABILITY AND THE LOGIC OF QUANTUM MECHANICS. James Christopher Thomas Pool. Thesis, Iowa City, Iowa, Iowa State Univ., 1963. 153p.

A mathematical construct, compatibility, corresponding to the physical concept of simultaneous observability was introduced by Mackey in his formulation of the logic of quantum mechanics. The properties of compatibility are studied, but first the axioms characterizing the logical structure associated with a quantum mechanical system are analyzed. The analysis is based on heuristic interpretations of only those observable quantities that correspond to experimental propositions, that is, questions about the physical system admitting only yes or no answers. In the investigation of compatibility, the question arises: does compatibility exhibit the following property? Property C: if p_1, p_2, and q are mutually compatible questions, then q is compatible with the least upper bound of p_1 and p_2. Since the least upper bound of p_1 and p_2 corresponds to the logical "or" of the experimental propositions represented by p_1 and p_2, Property C is extremely plausible in terms of our intuitive notions about physical systems. However, an example shows that there exist mathematical structures, which satisfy the axioms, without Property C being generally valid. The extreme plausibility of Property C for physical systems motivates the adoption of this property, and many properties of compatibility are deduced utilizing Property C. Further implications of the results of the analysis of the axioms and the investigation of compatibility are discussed and related to some other investigations of the logic of quantum mechanics. (M.P.G.)

12992 NONRELATIVISTIC SCATTERING THEORY. Tatuya Sasakawa (Kyoto Univ.). 151p. (CONF-327-13)

From Topical Conference on Compounds Nuclear States, Gatlinburg, Tenn., Oct. 1963.

A method of treating nonrelativistic scattering problems is presented. This gives the converging wave function and phase shift for potentials of usual use. The asymptotic form of the wave function is taken as the zero order function in the iteration. The scattering amplitude is determined self-consistently. When the partial wave is not coupled, this method is equivalent to the Jost's method. The discussion covers not only noncoupled partial waves but also coupled partial waves. Explicit formulas ready for calculation are given. The converging nature of this method enables the scattering length, the effective range, the resonance, and bound states to be discussed. The general pattern showing the distribution of resonances and bound states is given. The Levinson's theorem is valid for noncoupled partial waves, but it is violated in coupled partial waves. The resonance formula can be derived without introducing the channel radius. The phase shift formulas of all previous theories, whenever they converge, reduce to the formula derived. Bearing on the dispersion relation is also discussed. Criticism as to convergence of other methods are given. A quantum mechanically generalized WKB approximation, which does not require any knowledge about the turning point, is presented. (auth)

Geophysics

12993 (AD-410338) PARTICLE-COUNTING SATELLITE OBSERVATIONS MADE IN THE VICINITY OF THE JOHNSTON ISLAND HIGH-ALTITUDE NUCLEAR DETONATIONS OF 1963. Final Report. G. L. Johnson and R. B. Dyce (Stanford Research Inst., Menlo Park, Calif.). June 1963. Contract AF49(638)-1164. 38p.

Present information on the main and secondary radiation belts from the Star Fish shot is summarized, together with recent observations of artificial radiation belts associated with some apparent Soviet nuclear tests. Comparisons are made with the previous Argus, Teak, and Orange radiation belts. The instrumentation of the satellites is also described. (D.C.W.)

12994 (N63-17624) A FLEXIBLE METHOD OF DETERMINING THE ELECTRON DENSITY DISTRIBUTION IN THE IONOSPHERE. Scientific Report No. 190. J. R. Doupnik (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). Aug. 1, 1963. 78p.

A flexible method of obtaining the distribution of electrons in the ionosphere from both top- and bottom-side ionograms is developed for the digital computer. The electron-density profile is represented by a succession of parabolas in either plasma frequency or the natural logarithm of plasma frequency, such that the profile and its slope are continuous. Scaling of the ionograms may be done anywhere because the necessary coefficients are computed as needed. On the bottom side, ordinary and extraordinary modes may be reduced independently, or they may be combined in a least-squares formulation to compensate for unseen low-lying ionization. Results are presented for several assumed profile shapes in this region. A simple and effective technique of compensating for the variation of gyrofrequency with height is developed for the top side. The effects of inaccurate data and of the number of data samples are analyzed. (auth)

12995 (NASA-TN-D-1751) ELECTRON DENSITY DISTRIBUTION IN THE UPPER F-REGION. S. Chandra (National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.). Mar. 1963. 12p. (N63-14027)

A modified Chapman function with a variable scale height gradient was found to be in good agreement with the electron density distribution obtained experimentally within the height range of about 100 km below the F_2 peak to an altitude of about 700 km. The scale height distribution derived from this model is also consistent with the neutral-gas scale height of the 1961 COSPAR International Reference Atmosphere. (auth)

12996 (RTD-TDR-63-1050) ROCKETS IN SPACE ENVIRONMENT. VOLUME II. THE SPACE ENVIRONMENT. Aerojet Report No. 2484 (Final Report). N. A. Williams and D. Christensen (Aerojet-General Corp., Azusa, Calif.). Feb. 1963. Contract AF04(611)-7441. 59p. (AD-416157)

Environmental factors constituting the space environment between 300 and 22,000 nautical miles altitude are dis-

cussed and defined. These factors are ionizing particle radiation (including Van Allen, solar flare, and primary cosmic radiation), electromagnetic radiation (from both earth and sun), temperature and pressure in the exosphere, and meteoroids (both asteroidal and cometary). (116 references) (auth)

12997 (SID-63-656) A STUDY OF HIGH-ALTITUDE NUCLEAR BLAST DATA. Report No. 2, November 20, 1962–April 30, 1963. D. T. Hodder, B. J. Kotick, R. A. Fowler, and R. D. Elliott (North American Aviation, Inc. Space and Information Systems Div., Downey, Calif.). Aug. 30, 1963. Contract DA 36-039 AMC-00079(E). 293p. (AD-416133)

An analysis is given of geomagnetic and earth-current perturbation data resulting from high altitude nuclear blasts. Included is a description of spectral and cross-spectral analysis techniques for nuclear blast detection and identification criteria. (auth)

12998 (SSD-TDR-63-204) PRECIPITATION OF ENERGETIC ELECTRONS INTO THE ATMOSPHERE. G. A. Paulikas and S. C. Freden (Aerospace Corp. Physical Research Lab., El Segundo, Calif.). Aug. 21, 1963. Contract AF04(695)-169. 28p. (AD-416239; TDR-169(3260)TN-5)

Electron fluxes and spectra above 900 kev at altitudes between 200 and 700 km were measured in September and October 1962, using two near-polar satellites. The particle fluxes were observed with shielded solid state detectors having a 2π solid angle. The results show that electrons are lost from the radiation belts into the atmosphere along narrow ranges of L near L = 1.2 and L = 2, as well as in the L = 3 to 8 region. The L = 2 and L = 3 to 8 fluxes and spectra exhibit temporal variations. A typical precipitating flux at B = 0.35 gauss, L = 2.0 is 1000/sq cm sec with E > 0.9 Mev. A typical integral energy spectrum for L = 2, B = 0.35 gauss is E^{-3} between 0.9 and 1.7 Mev. Comparison of results with pre-Starfish measurements indicates that the fluxes of electrons observed near L = 1.2 and L = 2 are not connected with the high altitude explosion of July 9, 1962. (auth)

12999 (UAG-R136) ELECTRON CONTENT VARIATIONS IN THE AURORAL IONOSPHERE DETERMINED FROM SATELLITE RADIO OBSERVATIONS. Scientific Report No. 2. Jerry L. Hook (Alaska. Univ., College. Geophysical Inst.). May 1963. Contracts NAS5-1413 and Nonr-3010(04). 62p. (AD-413541)

The relation between the flux and energy spectrum of electrons penetrating to auroral heights, as measured by satellite instruments; the density and distribution of ionization measured by 20 and 40 Mc/sec radio transmissions; and the location and luminosity profiles of auroras as measured by ground stations in Alaska was investigated. The integrated electron density was obtained by the Doppler method, and the variations in the electron density were compared with simultaneous measurements of particle fluxes and auroral luminosity. The differential Doppler and Faraday methods are discussed, with emphasis on the former. The experimental results show that increases in electron density are morphologically correlated with regions of auroral luminosity and incident particle fluxes. (auth)

13000 (UCRL-7605) HIGH-TEMPERATURE THERMAL CONDUCTIVITY OF SIX ROCKS. D. R. Stephens (California. Univ., Livermore. Lawrence Radiation Lab.). Nov. 21, 1963. Contract W-7405-eng-48. 16p.

Values of the thermal conductivity of Nevada Test Site granite, basalt, tuff, and dolomite; Indiana limestone; and Gnome salt were measured to 1000°C using a steady-state method. Cylindrical rock samples were heated internally by a resistance-wire-wound porcelain tube and temperatures measured with thermocouples. The probable error in the data varied from ±5% to ±9%. These rather large values are believed due to the heterogeneous nature of the rock. (auth)

13001 A MODEL OF GEOMAGNETIC MICROPULSATIONS WITH LONG PERIODS. J. A. Jacobs and T. Watanabe (Univ. of British Columbia, Vancouver). Can. J. Phys., 42: 200-7(Jan. 1964).

A physical process whereby a hydromagnetic oscillation of a magnetic line of force passing through the auroral zones gives rise to a system of ionospheric currents is described. Geomagnetic micropulsations, at least in middle and low latitudes, are claimed to be due to ionospheric currents thus produced. Observational evidence in support of this viewpoint for micropulsations in the daylight hemisphere is provided by the solar eclipse effect that the intensity of micropulsations is weakened in the eclipsed zone. The phase relation between micropulsations in the north-south component and oscillations in the received frequency of a radio wave which is emitted from a station with a stable frequency of the order of several to tens of megacycles, and is propagated through the ionosphere, is correctly interpreted by the theory. (auth)

13002 VLF DISTURBANCES CAUSED BY TRAPPED BETA-RAYS FROM THE DECAY OF NEUTRONS PRODUCED IN HIGH-ALTITUDE NUCLEAR EXPLOSIONS. A. J. Zmuda, B. W. Shaw, and C. R. Haave (Johns Hopkins Univ., Silver Spring, Md.). J. Res. Natl. Bur. Std., 68D: 117-23(Jan. 1964).

Phase perturbations of vlf radio waves produced by nuclear detonation near Johnston Island on Oct. 20 and 26 and Nov. 1, 1962, are reported, and their temporal variation is attributed to trapped beta rays from neutron decay. The data from ground monitoring stations are analyzed. (R.E.U.)

13003 VLF ANOMALIES OBSERVED AT STATE COLLEGE, PA., DURING THE U. S. 1962 HIGH-ALTITUDE NUCLEAR TESTS. C. F. Sechrist, Jr. (HRB-Singer, Inc., State Coll., Penna.). J. Res. Natl. Bur. Std., 68D: 125-33 (Jan. 1964).

Phase and field intensity data taken following the 1962 high-altitude nuclear tests near Johnston Island are analyzed and mechanisms for the vlf anomaly are suggested. Enhanced D-region ionization produced by neutron-decay beta particles and by geomagnetically trapped fission-decay beta particles is reported. Results of preliminary computations, based on tapered- and step-ionosphere waveguide models and Wait's first-order theory for a variable height earth-ionosphere waveguide, are presented. (R.E.U.)

13004 GENERATION OF AN ELECTROMAGNETIC PULSE BY AN EXPANDING PLASMA IN A CONDUCTING HALF-SPACE. A. P. Stogryn and R. N. Ghose (Space-General Corp., El Monte, Calif.). J. Res. Natl. Bur. Std., 68D: 147-55(Feb. 1964).

The problem of the generation of an electromagnetic pulse by an expanding, infinitely conducting, spherical plasma under the earth is considered. The solution consists of the derivation of an appropriate tensor Green's function for the half-space that reduces the problem of determining the electric field at any point in space due to the current density generated by the interaction of the plasma with the earth's static magnetic field to evaluating an integral. The vertical component of the electric field at the earth's surface that is generated by the mechanism is calculated. (auth)

13005 DEPENDENCE ON LATITUDE OF ATMOSPHERIC HEATING DURING GEOMAGNETIC STORMS. Kenneth Moe (Thompson Ramo Wooldridge, Inc., Redondo Beach, Calif.). Nature, 201: 481-3(Feb. 1, 1964).

A model is presented of Joule heating of the upper atmosphere that shows the dependence of the temperature increase on geomagnetic latitude. (R.E.U.)

13006 PLANETARY AERONOMY XVI: CORPUSCULAR RADIATION IN THE UPPER ATMOSPHERE. A. Dalgarno (Geophysics Corp. of America, Bedford, Mass.). 34p. (CONF-228-2)

From International Association of Geomagnetism and Aeronomy 13th General Assembly of the International Union of Geodesy and Geophysics, Berkeley, Calif., Aug. 1963.

The efficiencies of fast electrons and protons in producing luminosity and heating by collisions with the atmosphere are discussed and upper limits to the fluxes of corpuscular radiation are obtained. A possible explanation of high-altitude red auroras is advanced. The effects of the photoelectrons produced in the ionization of the atmosphere by extreme solar ultraviolet radiation are examined, and it is noted that the electron temperature at high altitudes may be anomalously large at dawn, the phenomenon being accompanied by a red glow. It is suggested that the source of 1304 Å dayglow radiation postulated by Donahue and Fastie is excitation by impact of fast photoelectrons and that fast photoelectrons may lead to a large dayglow intensity of the first positive system of nitrogen through resonance scattering by metastable molecules. (auth)

Low Temperature Physics

Refer also to abstract 12333.

13007 (NP-13592) FINAL REPORT [ON APPLICATION OF ULTRASONICS TO THE STUDY OF SUPERCONDUCTIVITY]. R. W. Morse (Brown Univ., Providence). [1963]. Contract AF49(638)-6. 12p.

Superconductivity was studied using ultrasonics. Measurements of the temperature dependence of ultrasonic attenuation in superconductors upheld the BCS theory of superconductivity. Anisotropy of the energy gap in tin single crystals was, however, observed; and the different behavior in superconductors of longitudinal and shear waves was investigated. The Fermi surfaces of alkali metals, aluminum, noble metals and tin were examined by observations on the oscillatory behavior (periodic in H^{-1}) of ultrasonic attenuation as a function of magnetic field (H). (D.C.W.)

13008 (ORNL-3564(p.100-25)) MAGNETICS AND SUPERCONDUCTIVITY. (Oak Ridge National Lab., Tenn.).

Theoretical and experimental work indicates the merits of so-called "absolute B minimum field configurations" for plasma containment. The following special cases were studied: the magnetic field resulting from the superposition of a quadrupole field (Ioffe bars) and the regular magnetic field of DCX-2; three cases of field configurations produced by an axisymmetric coil arrangement suggested by Andreoletti; and a field configuration due to two infinitely long current loops, as described by Baker. Only the Ioffe bar arrangement produces a relatively large increase of the magnitude of B around the field axis in the zone of interest. The new magnet laboratory (described) went into operation. A method for constructing magnet coils from hollow tubular conductors that gives improved surfaces is also described. An extensive systematic study was made on models of high-field superconductors. Sets of equations for tube magnetization and magnetic moment curves have been derived which are more comprehensive than those previously published. Furthermore, a measurement method for simultaneous investigations on tube magnetization and magnetic moment of high-field superconductors is described. Finally, magnetic moment measurements of bundles of Nb–Zr wires are reported that gave reproducible results for complete magnetization cycles. These results are compared with calculated curves based on the model of Kim, and the connection with the flux-creep theory applied to a comparable case is discussed. (auth)

13009 THE MOLAR VOLUME AND EXPANSION COEFFICIENT OF LIQUID He^4. Eugene C. Kerr and R. Dean Taylor (Los Alamos Scientific Lab., N. Mex.). Ann. Phys. (N. Y.), 26: 292-306(Feb. 5, 1964).

The density of liquid He^4 under its own vapor pressure was measured over the range 0.5–2.8°K with a precision of about 0.006%. A direct pycnometric method was used; the cell was immersed in a liquid He^3 bath. Detailed measurements in the neighborhood of the lambda point temperature showed the density maximum to occur 0.006°K above T_λ. Analysis of these data and other available data yielded analytical equations from which the coefficient of expansion was determined. Below 2.14°K the Landau formulations of He II was found to represent the data. In the neighborhood of T_λ the density changes logarithmically in $|T - T_\lambda|$. Above 2.2°K all available data are fitted as a function of the He^4 vapor pressure. The behavior near T_λ is analyzed in terms of the theory of Buckingham and Fairbank. (auth)

13010 SUPERCONDUCTING COILS. R. H. Levy and Z. J. J. Stekly (Avco-Everett Research Lab., Everett, Mass.). Astronaut. Aeronaut., 2: No. 2, 30-8(Feb. 1964).

A brief description of the development of superconducting magnets is given, and the properties of various superconducting materials are discussed with special emphasis on Nb–Zr and Nb–Sn alloys. The problems of operating a magnet at liquid-helium temperatures are described. Applications of superconducting magnets for energy storage, radiation shielding, magnetohydrodynamics, and rotating electrical machinery are discussed. (C.E.S.)

13011 THE ONSET OF SUPERCONDUCTIVITY. A. J. Coleman (Queen's Univ., Kingston, Ont.). Can. J. Phys., 42: 226-7(Jan. 1964).

A criterion for the occurrence of a large eigenvalue of the second-order reduced density matrix σ is presented as a sufficient condition for the onset of superconductivity, and it is shown that energy considerations require that the occurrence of a large eigenvalue of σ coincides with large occupancy by fermi pairs of a two-particle Bloch state of constant center-of-mass momentum. (C.E.S.)

13012 SUPERCONDUCTING MAGNETS. D. Bruce Montgomery (Massachusetts Inst. of Tech., Cambridge). IEEE (Inst. Elec. Electron. Engrs.), Spectrum, 1: 103-13 (Feb. 1964).

The development of superconducting materials for high-field applications is discussed with emphasis on Nb–Zr and Nb–Sn. The applicability to d-c magnets, energy storage, and production of homogeneous fields is discussed. 41 references. (R.E.U.)

13013 IMAGE PROPERTIES OF A SUPERCONDUCTING GROUND PLANE. A. R. Sass (Lewis Research Center, Cleveland). J. Appl. Phys., 35: 516-21(Mar. 1964).

The Green's-function technique is utilized in the deter-

mination of the field distribution of an infinitely long current carrying conductor of arbitrary but constant cross section above a superconducting ground plane of finite thickness. It is assumed that the superconductor can be described by the phenomenological London equations. The integral expressions that are obtained are solved analytically for a few special cases of interest. Under conditions that are often encountered in a physical system, a modified image method can be utilized in order to calculate the field distribution to within 2% of the computer solution. (auth)

13014 VAPOR-DEPOSITED SUPERCONDUCTIVE FILMS OF Nb, Ta, AND V. C. A. Neugebauer and R. A. Ekvall (General Electric Research Lab., Schenectady, N. Y.). J. Appl. Phys., 35: 547-53(Mar. 1964).

The strong gettering action for oxygen or oxygen-containing gases displayed by Nb, Ta, and V was used to reduce the partial pressure of these gases in a vacuum system and allowed deposition from the vapor of superconducting thin films of these metals even at pressures of the residual gases higher than 10^{-5} torr, provided elevated substrate temperatures were used. Critical temperatures of the films were as high or higher than those of the bulk materials; the highest values were $T(Nb) = (9.81 \pm 0.05)°K$, $T(Ta) = (4.51 \pm 0.05)°K$, $T(V) = (6.02 \pm 0.10)°K$. Electron tunneling experiments demonstrated that the size and temperature dependence [$\epsilon(0) = 3.5T_c$] of the energy gap of these films is in good agreement with the BCS theory. Critical current vs magnetic field measurements at 4.2°K indicate that Ta films go normal at 220 to 240 Oe and Nb films at 9 to 15 kOe. Films of niobium prepared at low-substrate temperatures displayed inflated lattice parameters and were not superconductors. (auth)

13015 GETTER SPUTTERING FOR THE PREPARATION OF THIN FILMS OF SUPERCONDUCTING ELEMENTS AND COMPOUNDS. H. C. Theurer and J. J. Hauser (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys., 35: 554-5(Mar. 1964).

A new sputtering technique that eliminates the need for ultrahigh vacuums in preparing thin films of materials sensitive to gaseous impurities is described. This technique uses the gettering action of part of the sputtered atoms to produce an atmosphere within an anode can very low in reactive gases such as O_2 and N_2. In consequence, contamination by such interstitial impurities is prevented during deposition. The method has been successfully used for the preparation of superconducting films of materials such as Ta, Nb, V_2Si, V_3Ge, and V_3Ga. This technique in conventional vacuum equipment produces films of pure elements with superconducting properties comparable to those of bulk material. The method should be applicable also to the preparation of magnetic alloy films and epitaxial semiconductor films where contamination by reactive gases is a problem. (auth)

13016 SUPERCONDUCTING BEHAVIOR OF PRESSURE-INDUCED ZIRCONIUM POLYMORPH. B. Tittmann (Univ. of California, Los Angeles), D. Hamilton, and A. Jayaraman. J. Appl. Phys., 35: 732-3(Mar. 1964).

Superconductivity measurements were carried out in a He^3 cryostat for samples of α- and ω-phase Zr that were pressure- and heat-treated at up to 65 kbar and 1000°C. (R.E.U.)

13017 HARD MAGNETIC MATERIALS; SUPERCONDUCTORS. FLUX JUMPING IN Nb + 25% Zr WIRE. M. S. Lubell (Westinghouse Research Labs., Pittsburgh), G. T. Mallick, and B. S. Chandrasekhar. J. Appl. Phys., 35: 956-8(Mar. 1964).

Flux jumping was investigated in both cold-worked and heat-treated (1 hr at 700°C) 0.025-cm-diam Nb + 25% Zr wire wound into solenoids and noninductive coils of approximate dimensions: i.d. = 0.3 cm, o.d. = 1.2 cm, length = 2.6 cm. The measurements taken at 4.2°K were: (1) The induced voltage pulses vs applied magnetic field with both I = 0 and a preset transport current. (2) The induced voltage pulses vs coil current for H = 0 and with a preset uniform external field. For the case with no transport current in the coil (I = 0) when the external field was increased smoothly from zero, a sequence of very sharp voltage pulses (flux jumps) were induced in the coil, and recorded simultaneously on both an X–Y recorder and an oscilloscope. These flux jumps had the following general characteristics for all cases. (1) Starting from well defined initial conditions, the pulse always appeared at about the same place in the field sweeping cycle. (2) The polarity of the pulses is reversed when the direction of field change is reversed. (3) The pattern of these pulses was essentially unchanged when the field sweep rate was increased from 7 to 340 G/sec. As a result of these measurements, new insight into both the multilevel transitions of noninductive coils and the phenomenon known as degradation of solenoids is obtained. Two successful methods are described for partially overcoming the excessive degradation of a solenoid made from heat treated wire. The flux jumps are interpreted according to an extension of a model proposed by Bean and London. (auth)

13018 CRITICAL ALTERNATING CURRENTS IN SUPERCONDUCTORS. F. J. Young and H. L. Schenk (Westinghouse Electric Corp., Pittsburgh). J. Appl. Phys., 35: 980-1(Mar. 1964).

Critical alternating currents are studied experimentally in 0.96-cm lengths and coils of superconducting wire. Critical current density vs frequency are measured for three short Nb–25% Zr wires having the same amount of cold work. For the 5-, 10-, and 20-mil specimens, the critical a-c density varies from 290 to 170 kA/cm², 200 to 110 kA/cm², and 107 to 54 kA/cm², respectively, as the frequency is varied from 0.02 to 4.5 kc/sec. A short length of Nb–Ti wire 9 mils in diameter has a critical a-c density that varies from 260 to 130 kA/cm² as the frequency ranges from 0.01 to 4.5 kc/sec. In a 15-mil Nb_3Sn specimen, the critical a-c density is constant at 90 kA/cm² from 0.01 to 4 kc/sec. In a tightly wound Nb–25% Zr coil, the critical a-c density is found to vary inversely with the one-fourth power of frequency. In a very loosely wound coil of the same material, the critical a-c density varies inversely with the cube root of frequency. In all cases investigated, except for pure niobium, the exponent on the frequency varies from –0.25 to –0.36. In a Nb coil, no variation of critical a-c density is observed below 200 cps. Above 200 cps, it behaves in the same way as the other coils tested. The data indicate that the critical a-c density occurs such that the coil or short wire always becomes normal at the same level of power dissipation. (auth)

13019 MAGNETIC BEHAVIOR IN SUPERCONDUCTING Nb–Zr WIRE. Ko Yasukōchi (Nihon Univ., Tokyo), Takeshi Ogasahara, Nobumitsu Usui, and Shinataro Ushio. J. Phys. Soc. Japan., 19: 137-8(Jan. 1964).

The magnetization of Nb–Zr (25%) wire in a transverse field and peculiar properties of the remanence and hysteresis curve of the high-field superconducting wires are reported. (C.E.S.)

13020 HEAT CONDUCTIVITY OF COPPER BELOW 1°K. A. Dupré, A. Van Itterbeek, and L. Michiels (Institut

voor Lage Temperaturen en Technische Physica, Louvain, Belg.). Phys. Letters, 8: 99-100(Jan. 15, 1964).

The thermal conduction of two pure samples of copper was measured at 0.2 to 0.7°K in an attempt to investigate the effects of doping by chemical and physical impurities. (R.E.U.)

13021 SURFACE CONTOUR OF ROTATING LIQUID HELIUM II. R. Meservey (Yale Univ., New Haven). Phys. Rev., 133: A1471-5(Mar. 16, 1964).

The curvature of the free surface of a thin layer of liquid helium II resting on the horizontal bottom of a rotating cylindrical container (radius = 1.26 cm) was measured by a sensitive optical method. For a liquid depth of 5.0×10^{-3} cm and 1.11°K, the steady-state curvature was found to be indistinguishable from that of an ordinary viscous liquid for rotational speeds down to 0.29 rad/sec. Transient effects were observed that differ qualitatively from those of a normal viscous liquid. These results are discussed in relation to various theories of rotating helium and are compared with other measurements. (auth)

13022 ULTRASONIC MEASUREMENTS IN NORMAL AND SUPERCONDUCTING NIOBIUM. R. Weber (Massachusetts Inst. of Tech., Lexington). Phys. Rev., 133: A1487-92(Mar. 16, 1964).

Phonon attenuation versus temperature measurements were made on single-crystal niobium from 1.3 to 10°K for longitudinal phonon frequencies of 30 and 220 Mc/sec using the echo technique. The frequency dependence of the normal attenuation at 1.42°K was determined from 30 to approximately 450 Mc/sec. Time-of-flight shear and longitudinal measurements were made at 4.2°K and 30 Mc/sec. By averaging numerous experimental points it was calculated that the superconducting energy gap is $(3.63 \pm 0.06)kT_c$ for sound propagation along the [100], [110], and [111] crystallographic axes; that the normalized gap varies more strongly with the reduced temperature near T_c than is predicted by the BCS theory: that the Debye temperature at 4.2°K is (271 ± 5)°K, as calculated from the computed elastic constants; and that the ratio of superconducting-to-normal attenuation falls below the value predicted by BCS as the temperature is increased towards T_c for the 30-Mc/sec phonons. The attenuation varied as the square of the frequency below 110 Mc/sec, while for the higher frequencies the dependence on frequency decreased. Thus, at 220 Mc/sec, $ql \sim 1$. The samples were grown by an electron beam zone refining technique; and from well-oriented samples, experimental crystals were selected on the basis of mass spectrographic analyses and by measurements of T_c by the ultrasonic method. A typical acceptable sample was at least 99.8% pure and had T_c = (9.15 ± 0.02)°K. Other typical values were a resistivity ratio of 520 ± 50 and upper critical magnetic fields of 1710 ± 20 and 2020 ± 20 Oe at 4.2 and 1.4°K, respectively. The results are discussed in terms of several models and calculations. (auth)

13023 NUCLEAR MAGNETIC RESONANCE IN SOLID He^3—THE EXCHANGE BATH. Richard L. Garwin (Columbia Univ., New York) and André Landesman. Phys. Rev., 133: A1503-14(Mar. 16, 1964).

Spin-echo experiments were performed on β-phase He^3 and the exchange interaction J between He^3 atoms was measured in a consistent way, both by the "exchange narrowing" of the line (exchange lengthening of T_2) and by the strong reduction of T_1 at low magnetic fields ($\gamma H_0 \approx J$). J is found to increase very rapidly with increasing molar volume, ranging from less than 20 kc/sec at a lattice constant of 3.4 Å to 90 kc/sec at 3.5 Å, and to about 300 kc/sec at 3.6 Å. These exchange interactions are much too small to account for the "departure from the Curie law" found by Adams, Meyer, and Fairbank. It is shown that the susceptibility is, in fact, "Curie law" (in their temperature range) and that they were reporting as a susceptibility anomaly, the effect of a long exchange bath-lattice relaxation time. This exchange-lattice relaxation time varies as T^{-n} ($7 < n < 11$) and is ≈100 sec at 1°K for β-phase He^3 of 3.5 Å lattice constant. The results for the exchange-lattice relaxation time are compared with a modification of a theory by Griffiths. A major mystery remains; the exchange-bath heat capacity as measured by the spin-echo method exceeds the calculated value by $>10^3$. The exchange interaction is discussed and compared with the prediction of Saunders and others. (auth)

13024 λ ANOMALY IN THE HEAT CAPACITY OF SOLID HYDROGEN AT SMALL MOLAR VOLUMES. G. Ahlers and W. H. Orttung (Univ. of California, Berkeley). Phys. Rev., 133: A1642-50(Mar. 16, 1964). (UCRL-10757(Rev.))

Apparatus for the determination of properties of solid hydrogen at volumes between 15 and 23 cc/mole is described. The results of measurements on the λ anomaly in the heat capacity of solid hydrogen containing large concentrations of orthohydrogen are reported for molar volumes from 15.8 to 22.6 cc. The λ temperature was found to vary with intermolecular separation R as R^{-6}, with a small contribution from a higher exponent. This is in agreement with the expected relative contributions of electric quadrupole and valence interactions to the intermolecular potential. The relative contribution of the λ anomaly to the total anomalous entropy was estimated. The λ anomaly was found to have at least two distinct peaks. (auth)

13025 SURFACE IMPEDANCE OF NORMAL CONDUCTING FILMS DEPOSITED ON SUPERCONDUCTING SUBSTRATES. Hans Meissner and Robert V. Fanelli (Stevens Inst. of Tech., Hoboken, N. J.). 11p. (CONF-301-27)

From International Conference on the Science of Superconductivity, Hamilton, N. Y., Aug. 1963.

Microwave absorption at 9 kMc in gold and copper films on tin substrates was found not to extrapolate to zero at absolute zero for films thicker than 500 Å. The penetration depth in gold-plated single crystals of tin was measured, and the resonance curves of the LC circuit were used to determine the value of the superconducting penetration depth with gold thickness. It is shown that the films adjoining tin behave normally rather than possessing a finite energy gap. (R.E.U.)

Neutron Physics

13026 (AE-129) THE P_1-APPROXIMATION FOR THE DISTRIBUTION OF NEUTRONS FROM A PULSED SOURCE IN HYDROGEN. A. Claesson (Aktiebolaget Atomenergi, Stockholm). Dec. 1963. 20p.

An analytic expression (exact solution) is obtained for the distribution in a P_1 approximation. The solution, however, is quite complex, and it is shown that an asymptotic solution can be obtained in a simpler manner. By taking into account the low hydrogen scattering cross section at the source energy, it follows that the space dependence of the distribution is less than that obtained previously. The importance of keeping the time derivative of the first moment is further shown in a perturbation approximation. (auth)

13027 (AHSB(S)R-60) A FOUR-GROUP DIFFUSION THEORY CALCULATION METHOD FOR REFLECTED HOMOGENEOUS SYSTEMS. J. H. Chalmers and G. Walker (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch, Risley, Lancs, England). 1964. 23p.

The use of a 4-group calculation method to derive fast and thermal group constants for moderated homogeneous systems is described. These constants are then used to determine reflected critical sizes by the standard 2-group method. (auth)

13028 (AWRE-NR-5/63) MEASUREMENT OF NEUTRON SPECTRA BY SEMI-AUTOMATIC SCANNING OF RECOIL PROTONS IN PHOTOGRAPHIC EMULSIONS. P. W. Benjamin and G. S. Nicholls (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Dec. 1963. 28p.

The speed and accuracy of measuring neutron energy spectra by the nuclear emulsion technique were improved by equipping the microscope to give automatic read out. The recoil track co-ordinates are punched directly on to computer cards. A scanning rate of 100 to 150 tracks per hour was achieved. The exposure, development, and scanning techniques; the microscope modifications; and the computer program used to analyze the results are described. (auth

13029 (D2-4643-2) MONTE CARLO STUDIES OF NEUTRON PENETRATION. Salvador B. Layne (Boeing Co., Seattle). Aug. 8, 1962. 61p. (X63-14478)

The development of three Monte Carlo codes (NUPS-1, NUPS-3, and NUPS-4) for computing the transmission of fission neutrons through a slab of liquid hydrogen is discussed, along with the efficiency of the various combinations of variance-reducing techniques incorporated in these codes. Write-ups and listings of the finished codes, expositions on the techniques of conditional Monte Carlo, and importance sampling with truncated distributions, as well as the sampling schemes proposed for NUPS-5 and NUPS-6, are given. (auth)

13030 (GA-4434) DIFFERENTIAL NEUTRON THERMALIZATION. Annual Summary Report, October 1, 1962–September 30, 1963. W. L. Whittemore (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Oct. 15, 1963. Contract AT(04-3)-167. 96p.

An electron linear accelerator with a neutron velocity selector was used to study inelastic scattering of monoenergetic neutrons by some moderators at incident energies of 0.009 to 0.40 ev. Most of the later work was performed with E > 0.20 ev. The exact energies were chosen to permit study of various rotation and vibration levels. Results for liquid methane, liquid parahydrogen, zirconium hydride, and polyethylene are presented. (D.C.W.)

13031 (GA-4436) GGC-II—A PROGRAM FOR USING THE GAM-II AND GATHER-II SPECTRUM CODES IN PREPARING MULTIGROUP CROSS-SECTION INPUT ON PUNCHED CARDS FOR THE GAZE, GAZED, DSN, GAPLSN, 2DXY, TDC, GAMBLE, FEVER, AND GAD CODES. C. V. Smith and H. A. Vieweg (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Dec. 17, 1963. 34p.

The GGC-II program, which calculates the spectrum-averaged cross sections using the GAM-II and GATHER-II programs, is described. The program is mainly in FORTRAN II for use on an IBM 7090 computer with a 32K memory. (D.C.W.)

13032 (IA-856) SPECTRUM OF THE CENTRAL GROUP OF NEUTRONS, FROM Po–Be AND Pu–Be SOURCES, MEASURED BY THE TIME-OF-FLIGHT TECHNIQUE. D. Sadeh, A. L. Catz, and S. Amiel (Israel. Atomic Energy Commission. Soreq Research Establishment, Nahal Soreq). Dec. 1963. 8p.

The spectrum of neutrons from Po–Be and Pu–Be sources populating the 4.45-Mev level of C^{12} was analyzed by the time-of-flight technique. Two peaks corresponding to neutron energies of 3.8 ± 0.15 and 5.5 ± 0.15 Mev were clearly identified. As a possible explanation of the shape of the spectrum, a strongly peaked forward emission of neutrons is discussed. The measurements were made using a time-of-flight analyzer of 1.5-ns resolution with an improved pulse shape gamma ray discriminator. (auth)

13033 (ORNL-TM-788) ON GROUP REBALANCING AS USED IN THE EQUIPOISE METHOD. Melvin L. Tobias (Oak Ridge National Lab., Tenn.). Feb. 5, 1964. Contract W-7405-eng-26. 6p.

It is shown that the group rebalancing method will always yield positive rebalancing factors regardless of the complexity of the scattering matrix in eigenvalue reactor problems calculated by the EQUIPOISE method. The proof is based upon elementary principles of linear equations and requires only that the neutron flux estimates be all positive and that a single fission spectrum be used. (auth)

13034 ANISOTROPIC SCATTERING IN HALF-SPACE TRANSPORT PROBLEMS. Fred Shure and Michael Natelson (Univ. of Michigan, Ann Arbor). Ann. Phys. (N. Y.), 26: 274-91(Feb. 5, 1964).

Case's singular normal mode analysis of half-space transport problems is extended to include anisotropic scattering. The cases of absorbing and nonabsorbing media are treated separately. By way of illustration, the solution to the Milne problem is obtained in each instance. It is shown that the results may always be written in terms of an appropriate X-function, and a rapidly convergent iterative scheme for evaluating the X-functions is exhibited. However, differences from the isotropic scattering problem arise: For the nonabsorbing medium the zeros of the characteristic function coalesce at infinity; for the absorbing medium, the normal mode analysis contains undetermined constants that are seen to be related to coefficients in the Laurent series of the X-function. In each case the solution is carried out with the appropriate modifications, and Case's three X-function identities are rederived. (auth)

13035 MULTIPLICATION OF FISSION NEUTRONS IN BERYLLIUM OXIDE. I. F. Zhezherun. At. Energ. (USSR), 15: 505-6(Dec. 1963). (In Russian)

The previously determined multiplication factor K_{Be} of fission neutrons in Be (I. F. Zhezherun et al. Atomnaya Energ. 15, No. 6, 485-9 (1963)) was used to estimate the corresponding value K_{BeO} in the oxide, without knowing the exact values of the cross sections of the $Be^9(n,2n)$ and $Be^9(n,\alpha)$ reactions. Inasmuch as the multiplication of the neutrons is due to their collisions with the Be atoms, the number of the newly generated neutrons must be proportional to the number of collisions of the fission neutrons, N_{Be} or N_{BeO}, with energies exceeding the value of the threshold energy, E_n, of the above reactions with the Be atoms slowed down in the Be or BeO. The values given in the compilation of D. Hughes and R. Schwartz were used in the calculation. Extrapolations were made in the ranges in which no data are available. The value of the multiplication factor thus calculated is $K_{BeO} = 1.08 \pm 0.023$. (TTT)

13036 SPECTRAL ANALYSIS OF THE ANISOTROPIC NEUTRON TRANSPORT KERNEL IN SLAB GEOMETRY

WITH APPLICATIONS. A. Leonard and T. W. Mullikin (RAND Corp., Santa Monica, Calif.). J. Math. Phys. (N. Y.), 5: 399-411(Mar. 1964).

A spectral analysis of the transport kernel for anisotropic scattering in finite slabs is achieved by first solving a type of generalized scattering problem for a subcritical slab. Initially, the scattering problem is stated as an inhomogeneous integral transport equation with a complex-valued source function. This is readily transformed to singular integral equations and linear constraints in which the space and angle variables enter as parameters. Dual singular equations appear in applications of Case's method to transport problems, but we cannot yet completely explain this duality. The singular equations are transformed to Fredholm equations by an extension of Muskhelishvili's standard method and by analytic continuation. It is shown that, for a wide class of scattering functions, this particular Fredholm reduction yields equations that converge rapidly under iteration for all neutron productions and slab thicknesses. The ultimate solution of the singular equations contains arbitrary constants that, when evaluated by the linear constraints, display explicitly the Fredholm determinant and the eigenfunctions of the transport kernel. An immediate consequence of this result is the criticality condition and the associated neutron distribution. Specific applications to linear anisotropic and isotropic scattering in slab geometry are discussed. It is seen that the case of isotropic scattering in spheres can be treated with this method, and, in fact, the spectral analysis of the kernel for the slab problem immediately applies to the sphere kernel. (auth)

13037 APPLICATIONS OF THE WIGNER REPRESENTATION TO THE THEORY OF SLOW NEUTRON SCATTERING. Marcos Rosenbaum. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1963. 150p.

A Wigner representation is used for expressing the thermal average occurring in the Van Hove formalism for slow-neutron scattering from macroscopic systems. For quadratic and lower-degree potentials, results in closed form may be obtained, and in general, an asymptotic series expansion in powers of $\hbar$ is still possible for the incoherent part of the differential cross section for quasiclassical systems. The lead term of this asymptotic expansion results in an expression relating the cross section to a 4-dimensional Fourier inversion of the classical space-time distribution $G_s^c(\mathbf{r},t)$ and, hence, to the classical motions of the atoms in the scattering system. Correction terms of $o(\hbar^2)$ have been obtained explicitly and found to be small for systems at ordinary temperatures. It is shown that, because of the contact nature of the Fermi pseudo-potential, the exact classical limit ($\hbar \to 0$) for any system is the ideal-gas result. The derivation involves the application of "Weyl's rule," which is rederived in a manner felt to be slightly more understandable than previous derivations and, in addition, extended to Heisenberg operators. In principle, the results can be extended to all orders of $\hbar^2$. No similar asymptotic expansion appears to exist, however, for the coherent cross section. An alternate approach to the interpretation of slow neutron scattering data, based on the use of a specific model Hamiltonian, is illustrated for the case of a monatomic liquid. The model used, originally proposed by Ookawa, is of the crystalline dislocation type and leads to a sum of gas and oscillator Hamiltonians. The incoherent intermediate and scattering functions were found very conveniently from such Hamiltonians by using the Wigner representation previously introduced. The width of the intermediate scattering function for liquid Pb was then compared with other models and available experimental results. (Dissertation Abstr.)

13038 EXPERIMENTATION WITH THERMAL NEUTRON WAVE PROPAGATION. R. B. Perez, R. S. Booth, and R. H. Hartley (Univ. of Florida, Gainesville). 7p. (CONF-187-67)

From American Nuclear Society Meeting, New York, Nov. 1963.

The propagation of thermal neutron disturbances is discussed. The real and imaginary parts of the complex inverse relaxation length are given as a function of frequency for two energy modes in 1.68-g/cm graphite. (R.E.U.)

Nuclear Properties and Reactions

Refer also to abstracts 12453, 12891, 12895, and 12896.

13039 (AEEW-R-254) NEUTRON REACTION DATA FOR SODIUM IN THE ENERGY RANGE 0.01 ev TO 14 Mev FOR THE WINFRITH NUCLEAR DATA FILE. T. P. Moorhead (United Kingdom Atomic Energy Authority. Reactor Group. Atomic Energy Establishment, Winfrith, Dorset, England). Apr. 1963. 41p.

A new compilation of nuclear cross-section data for sodium, covering the energy ranges of interest to both fast and thermal reactors, is described. Data were added on high energy reactions, angular distributions, and secondary energy laws and distributions for elastic and non-elastic reactions. The report records a number of relations needed in connection with angular distributions, co-ordinate transformations, and secondary energy laws. In addition, some nuclear theory calculations for Na^{23} with the program ABACUS are described. Good agreement between theory and experiment at 4 Mev was obtained by fitting the parameters, and the program was used to predict elastic and inelastic reaction data at higher energies. (auth)

13040 (CERN-63-37(p.203-13)) ELASTIC NEUTRINO INTERACTIONS. J. Loevseth (European Organization for Nuclear Research, Geneva).

The process $\nu + n \to p + l^-$ (l = lepton) when the neutron is contained in a nucleus is considered. The ideal Fermi gas, corresponding to an infinitely deep potential well, is used as the nuclear model. The probability for the recoil nucleon to get out of the nucleus and the analysis of elastic events are discussed. (C.E.S.)

13041 (CNAEM-12) SYSTEMATICS OF FISSION ASYMMETRY WITH RESPECT TO NUCLEAR CHARGE AND NEUTRON CONTENTS. M. Talat-Erben and Binay Gueven (Turkey. Atomic Energy Commission. Cekmece Nuclear Research Center, Istanbul). 1963. 19p.

Swiatecki's asymmetry formula was applied to charge and neutron asymmetry in fission. The constants involved were determined from the average isotopic and isotonic yields in the thermal neutron fission of U^{235} and Pu^{239}, calculated by the integral transform procedure applied to the experimental isobaric yield curves for these nuclides. The average proton and neutron contents were then determined from the asymmetry equations for the fission fragments of the compound nuclei Th^{233}, U^{234}, U^{236}, U^{239}, Cm^{242}, and Cf^{252}. The relation between the average charge and mass of the light and heavy fragments leads to two almost parallel straight lines that practically coincide with Z_p vs A lines for neutron fission of U^{235}, implying that the relation between the most probable values of fragment

charge and mass is independent of the fissioning nucleus; in other words, this relationship is universal. The average charge and mass of the light fragment vary within much wider limits (8 charge units and 18 mass units, respectively) in comparison to the heavy fragment charge and mass which vary in a much narrower range (2 charge units and 6 mass units, respectively), signifying that the fission process is more selective with respect to the heavy fragment composition. A neutron added to the original nucleus goes preferentially (90%) into the heavy fragment and transfers some charge (15% of one charge unit) from the light to the heavy fragment. On the other hand, a proton added to the original nucleus goes into the light fragment and transfers from the heavy to the light fragment a little more charge (10% of one charge unit) as well as a substantial amount (1.25 units) of neutrons. These effects are perfectly additive with respect to both the number of neutrons and that of protons added, and permit prediction of the average charge and neutron contents of the two fragments for any fissile nuclide, if these quantities are known for any other reference nuclide. (auth)

13042 (CONF-22-30) ENERGY LEVELS OF B^{10}. Technical Report No. 300. W. F. Hornyak, C. A. Ludemann, and M. L. Roush (Maryland. Univ., College Park). Apr. 1963. Contract [AT(30-1)-2464]. 52p.

From American Physical Society 1963 Annual Meeting, New York, Jan. 1963.

The level structure in B^{10} revealed through proton reactions with Be^9 at 0.7 to 2.0 Mev, is examined in light of new absolute cross section measurements for radiative capture and an analysis of the (p,d) differential cross sections previously reported. Radiative widths of prominent branches for resonance levels at E_p = 938, 992, 1084, and 1290 kev are determined. Spectroscopic designations and reduced widths are assigned and discussed for seven levels corresponding to resonances at 938, 980, 992, 1084, 1150, 1290, and 1650 kev. Proposed spins and parities are 2^-, 2^+, 2^-, 0^+, 1^+, 2^-, and 2^-, respectively. An alternate assignment of 1^+ and 2^- for the levels at E_p = 938 and 1150 kev is also possible with the additional possibility that the 1150 and 1290 levels are in fact identical. The level at E_p = 1650 kev may be 2^+ in character. Three more hindrance factors illustrative of the Morpurgo rule are determined for the proposed branching ratios in the decay of the 3.58-Mev level in B^{10}, in view of a newly discovered E2 branch in this decay. (auth)

13043 (GA-4490(Rev.)) NEUTRON INTERACTIONS IN ZIRCONIUM HYDRIDE. W. L. Whittemore (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Jan. 6, 1964. Contract AT(04-3)-167. 36p.

Earlier measurements of neutron interactions in zirconium hydride are reviewed and combined with the latest results obtained with the neutron velocity selector. Recent measurements included the angular dependence of purely elastic scattering from hydrogen atoms in zirconium hydride, the angular dependence of scattering from the first and second excited level, the width of the first and second excited levels, and the temperature and angular dependence of the level width. These results are compared with predictions for a harmonic oscillator. The significant deviations indicate that the potential well for the hydrogen atom differs appreciably from purely harmonic. The temperature and angular dependence of the width of the first excited level clearly indicate that the level width is mainly due to causes other than Doppler broadening. (auth)

13044 (JINR-E-1471) MEASUREMENTS OF STOPPED π^- MESON ABSORPTION PROBABILITY BY BOUND HYDROGEN NUCLEI. A. F. Dunaitsev, V. I. Petrukhin, and Yu. D. Prokoshkin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1963. 14p.

The probability of stopped π^--meson capture by hydrogen nuclei in polythene (CH_2) was measured by the relative method free of systematic errors characteristic of earlier experiments. (auth)

13045 (JINR-P-1470) O PEREZARYADKE OCTANOVIVSHIKHSYA π^--MEZONOV NA SLOZHNYKH YADRAKH. (On the Charge Exchange of Stopped Negative Pions). V. I. Petrukhin and Yu. D. Prokoshkin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1963. 5p.

It is shown that mesonsπ^- charge exchange on complex nuclei is sharply suppressed. (auth)

13046 (JINR-P-1472) ROZHDENIE $\Lambda(\Sigma^0)$-GIPERONOV I K^0-MEZONOV PRI VZAIMODEISTVII π-MEZONOV S ENERGIEI 7 Gev S UGLERODOM. ($\Lambda(\Sigma^0)$ and K^0 Production in 7-Gev π^-Meson Interaction with Carbon). V. A. Belyakov, A. V. Boyadzhiev, Yung-ch'ang Wang, et al. (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1963. 20p.

The production of hyperons (Λ and Σ^0) and mesons (K^0) on carbon at the incident meson (π^-) energy of 7 Gev was investigated. The angular and momentum distributions of these particles were obtained; their production cross sections were determined; and the cross sections for different channels of the reactions were estimated. The fraction of strange particles produced in secondary processes was first estimated. The experimental data are compared with the calculations by the cascade theory. It is shown that the cascade theory is valid for the class of the investigated phenomena. (auth)

13047 (JINR-P-1495) O KOLLEKTIVNYKH VOZBUZHDEINYAKH YADER PRI RASSEYANII ELEKTRONOV. (On Collective Excitations of Nuclei in Electron Scattering). V. K. Luk'yanov and I. Zh. Petkov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1964. 10p.

The excitation of rotating and vibrational states of nuclei in electron scattering is treated. The differential scattering cross sections were obtained for the case of two 2^+ levels in Mg^{24} and O_β^+ of the vibrational level in Gd^{156}. The approximations used are discussed. An experimental possibility of studying such excitations is indicated. (auth)

13048 (JINR-P-1510) KONVERSIONNYE ELEKTRONY IZOTOPOV ITTRIYA. (Conversion Electrons of Yttrium Isotopes). K. Ya. Gromov, A. S. Danagulyan, A. T. Strigachev, and Mo-lung Chou (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1963. 8p.

A spectrum of conversion electrons of the isotopes Y^{85}, Y^{87}, and Y^{89} was studied with the help of a β spectrograph with the constant magnet and photoplates. The yttrium isotopes were obtained by bombarding the metallic niobium by 660-Mev protons and separated by the radiochemical method without a carrier. The energy level was found to be 478.6 kev in the Y^{90} isomer. The energy levels for Sr^{85} isomer were found to be 231.9 and 239.1 kev. A balance of the intensities in Sr^{85m} decay is calculated. (auth)

13049 (MLM-914) PROCESSING AND PROPERTIES OF POLONIUM-208. G. L. Fox, G. D. Nelson, and W. H. Powers (Mound Lab., Miamisburg, Ohio). Jan. 17, 1964. Contract AT(33-1)-Gen-53. 26p.

A total of 9.243 curies Po^{208} was produced by 19-Mev and 23-Mev proton irradiation of bismuth, and purified. Polonium produced by a 19-Mev beam contained 15.5 to

20.5 wt % Po^{208}; by a 23-Mev beam, an average of 9 wt %. Submicrocurie to multicurie quantities of plonium in massive amounts of bismuth were concentrated with up to 98% recovery. A tellurium carrier process for purifying microcurie quantities of polonium recovered about 70%; a noncarrier stannous chloride process for purifying millicurie to multicurie quantities recovered 88%. Gamma to alpha intensity ratios of 10.3×10^{-5} and 8.56×10^{-6}, respectively, were determined for purified polonium prepared by irradiation with 19 and 23-Mev protons. Gamma radiations associated with Po^{208} and Po^{209} (0.89, 0.58, 0.27, and 0.07 Mev) were assumed to be from Po^{209}. Lead and iron impurities in the irradiated bismuth formed gamma-emitters Bi^{205}, Bi^{206}, and Co^{56}. The iron in the aluminum backing produced Co^{56}. Po^{208} neutron sources meeting Mound Laboratory specifications for Po^{210} neutron sources were prepared. The range of Po^{208} alpha particles was determined to be 3.66 cm in air at 15°C and one atmosphere. The half life of the alpha radiation is 2.89 ± 0.01 years. (auth)

13050 (NAA-SR-Memo-9174) MODIFICATIONS AND EXTENSIONS OF THE FORM CODE. R. A. Blaine (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 1963. Contract [AT(11-1)-Gen-8]. 13p.

Changes in the FORM program are described, together with their use. An element-wise removal cross section that includes both elastic and inelastic transfers of neutrons is calculated, and an option permits a reduction in printing. The resonance scatterer option that was in MUFT IV was also restored, and an option by which fast fission can be modified to account for fuel lumping was added. (D.C.W.)

13051 (NAA-SR-Memo-9214) COMPARISON OF METHODS OF CALCULATING FAST NEUTRON SCATTERING FROM BERYLLIUM. J. A. Belcher (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 12, 1963. Contract [AT(11-1)-Gen-8]. 12p.

The fast neutron flux scattered by the SNAP 10A/2 control drums has been calculated with ray tracing codes 14-0 and SCAR 1. A Monte Carlo code, ANNEX 2, has successfully predicted the results from some recent scattering experiments at Oak Ridge. The accuracy of the SNAP 10A and SNAP 2 control drum scattering calculational methods was checked with a devised problem that could be analyzed with 14-0, SCAR 1, and ANNEX 2. The comparison indicated that no major error was made in SNAP 10A or SNAP 2 control drum scattering calculations performed to date. (auth)

13052 (NAA-SR-Memo-9314) MAC—A COMPUTER PROGRAM FOR MAKING ADDITIONS AND CORRECTIONS TO THE MONTE CARLO CROSS SECTION LIBRARY TAPE. R. E. Kaiser (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 12, 1963. Contract AT-11-1-GEN-8. 61p.

The program MAC, designed to correct cross sections for a given element and to add new elements, is described. Up to five changes can be made at one time, and the program handles libraries of up to 50 elements. Input is illustrated; and flow diagrams are included, together with the program listing. (D.C.W.)

13053 (NASA-TN-D-2170) DIRECT REACTION CALCULATION. W. R. Gibbs (Los Alamos National Lab., N. Mex.); V. A. Madsen, E. C. Cox, L. Mowry (National Aeronautics and Space Administration. Lewis Research Center, Cleveland); J. A. Miller (Texaco Research Lab., Bellaire, Tex.); and W. Tobocman (Case Inst. of Tech., Cleveland). Feb. 1964. 44p.

The FORTRAN program DRC, which calculates transition amplitudes and cross sections on the basis of the distorted-wave Born approximation (DWBA), is described. The incident- and the outgoing-channel wave functions used in the DWBA are descriptive of elastic scattering by an optical potential. The differential cross section for elastic scattering can be calculated in both incident and outgoing channels. The following types of nuclear reactions can be treated by DRC: inelastic scattering, knock-out, projectile stripping, and target stripping. (auth)

13054 (NP-13560) PHOTONUCLEAR REACTIONS IN A UNIFIED THEORY. Technical Report 343. W. M. MacDonald (Maryland. Univ., College Park). Dec. 1963. 20p.

Photonuclear reactions are treated within the framework of the unified theory presented previously. The transition amplitude is the sum of a non-resonant direct transition matrix element and of a resonant compound nuclear term determined by an effective interaction. The difficulties associated with the use of virtual states are discussed and resolved. (auth)

13055 (NRL-5897) AN INVESTIGATION OF THE PHENOMENOLOGICAL CHARACTERISTICS OF (p,γ) RESONANCES. R. O. Bondelid and J. W. Butler (Naval Research Lab., Washington, D. C.). Dec. 7, 1962. 59p. (AD-407036)

The observation of some anomalies in the behavior of gamma resonances induced by hydrogen molecular ion beams led to an investigation of these and other new anomalies, including some involving proton beams. Most of the observations were made with respect to the 992-kev resonance in the $Al^{27}(p,\gamma)Si^{28}$ reaction, but the following were also used: the 1317-kev resonance in the same reaction, the 1747-kev resonance in the $C^{13}(p,\gamma)N^{14}$ reaction, the 1424-kev resonance in the $Ni^{58}(p,\gamma)Cu^{59}$ reaction, and the 1843-kev resonance in the same reaction. The anomalies for H_1^+ beams are all satisfactorily explained on the basis of fluctuations in energy loss of the bombarding protons as they penetrate the target. Detailed numerical integrations of the formal yield equation were made, and in most cases very good fits were made with the experimental data. Precise best values are given for the following narrow (p,γ) resonances: $Al^{27}(p,\gamma)Si^{28}$ reaction, 991.91 ± 0.30 and 1317.19 ± 0.40 kev; $C^{13}(p,\gamma)N^{14}$ reaction, 1747.06 ± 0.53 kev; $Ni^{58}(p,\gamma)Cu^{59}$ reaction, 1423.64 ± 0.43 and 1843.45 ± 0.56 kev. The displacement of the midpoint of the rise of a thick-target H_1^+ yield curve from the resonance energy E_r as a function of the resonance width Γ is discussed, and a typical curve of this relationship is shown. The overshoot or hump height for thick targets with H_1^+ beams as a function of Γ is also considered, and a curve is shown. (auth)

13056 (ORNL-TM-771) STATISTICAL FLUCTUATIONS IN THE OUTPUT OF AN INTRANUCLEAR CASCADE MONTE CARLO COMPUTATION. R. W. Peelle (Oak Ridge National Lab., Tenn.). Jan. 17, 1964. Contract [W-7405-eng-26]. 14p.

The magnitude of the statistical fluctuations in the differential secondary-nucleon cross section output by the Bertini intranuclear cascade computation was estimated and compared to the scatter observed between successive Monte Carlo outputs. Poisson statistics are found to be adequate to explain the fluctuations in the number of outgoing particles estimated for small energy and angle ranges. A chi-square test with one degree of freedom was performed for each energy and angle bin; and both

the distribution of these values and the combined chi-square test confirm the reasonableness of the estimated variances. To explain the fluctuations in the output of the associated nucleon evaporation program, it is necessary to employ variance estimates based on a binomial approximation. (auth)

13057 (ORNL-TM-795) A TABULATION OF INTEGRATED NEUTRON AND FLUX INTENSITIES FOR FISSION SPECTRA FROM 0.01 TO 25 Mev. J. Halperin and R. W. Stoughton (Oak Ridge National Lab., Tenn.). Feb. 7, 1964. Contract W-7405-eng-26. 70p.

The fission neutron spectrum was tabulated as a function of energy for several analytical expressions that were fitted to experimental data for thermal fission in U^{235}, U^{233}, Pu^{239}, and spontaneous fission in Cf^{252}. The integrated neutron density and flux were calculated for energies from 0.01 to 25 Mev in intervals of 0.05 Mev. (auth)

13058 (UCRL-10798) EVIDENCE FOR A NEW REGION OF DEFORMATION WITH LESS THAN EIGHTY-TWO NEUTRONS (thesis). Richard N. Chanda (California. Univ., Berkeley. Lawrence Radiation Lab.). Apr. 29, 1963. Contract W-7405-eng-48. 81p.

Experimental evidence for a new region of nuclear deformation in the neutron-deficient rare earths was obtained through the use of reactions of the type (heavy ion, xn) leading to several new neutron-deficient lanthanum isotopes. Three previously unreported lanthanum isotopes were identified: La^{126}, La^{128}, and La^{130}, with half-lives of 1.0 ± 0.3, 6.1 ± 0.6, and 9.0 ± 1.0 min respectively. The decays of these odd-odd lanthanum isotopes were investigated using $\gamma-\gamma$ coincidence spectroscopy and partial level schemes are proposed for the respective even-even daughter barium isotopes. Observed energy levels with their proposed spins and parities are given for Ba^{126}, Ba^{128}, and Ba^{130}. Systematics of deformed nuclei are discussed in general and the barium nuclei compared with other deformed nuclei from other regions of deformation. Evidence for the existence of deformation is derived both from the energies of the first excited states and from the ratios of energies expected and observed in rotational bands in even-even nuclei. (auth)

13059 SCATTERING OF 4.90- AND 5.30-Mev PROTONS BY ALUMINUM. H. Hulubei, I. Neamu, I. Francz, N. Martalogu, N. Scintei, M. Ivascu, and A. Berinde (Inst. of Atomic Physics, Bucharest). Acad. Rep. Populare Romine, Studii Cercetari Fiz., 14: 741-5(1963). (In Rumanian)

The angular distributions of elastically and inelastically scattered protons ($Q = -0.84$, -1.01, and -2.21 Mev), at incident energies of 4.90 and 5.30 Mev, were measured. All the distribution curves obtained have similar forms. A decrease of the energy of the incident protons corresponds to an increase of the scattering cross section. An augmentation of the effects of compound nuclei in the range of energy studied is suggested. (tr-auth)

13060 NUCLEAR RESONANCE FLUORESCENCE INVESTIGATIONS OF THE TELLURIUM ISOTOPES 122 AND 124. Wolfgang Zimmermann (Universität, Marburg, Ger.). Ann. Physik (7), 12: 45-56(Oct. 1963). (In German)

By means of the method of nuclear resonance fluorescence the lifetimes of the first excited states of Te^{122} and Te^{124} were determined. The following values were obtained: for the 0.564-Mev state in Te^{122}, $\tau = (13.2 \pm 3.3)$ psec, and for the 0.603-Mev state in Te^{124}, $\tau = (6.2 \pm 0.4)$ psec. (tr-auth)

13061 EFFECTIVE CROSS SECTIONS FOR THE PRODUCTION OF POSITRON RADIATION BY FAST NEUTRONS. Fritz Hertlein (Technische Hochschule, Munich). Ann. Physik (7), 12: 57-83(Oct. 1963). (In German)

The absolute positron activation cross sections for several (n,2n) processes and the reaction $Ni^{58}(n,p)Co^{58}$ were determined in the "clean" neutron spectrum of the Munich Research Reactor. For elimination of the high background activity, which originates chiefly from (n,γ) processes, a difference-coincidence method was used, by which the positron activity was detected by coincidences between the annihilation quanta in two scintillation counters standing opposite one another. The determination of the total detection probability of the arrangement for annihilation quanta coincidences was carried out with a calibrated Na^{22} preparation. As a reference process for absolute determination of the effective cross section, the $S^{32}(n,p)P^{32}$ reaction, whose energy-dependent activation cross section is well known, was used. Results were compared with values calculated from the continuum theory of Feshbach and Weisakopf. A satisfactory agreement between theoretical and experimental results was observed. In agreement with a hypothesis of Hurwitz and Bethe, no general difference in the pattern of the (n,2n) cross section between target nuclei with even, uneven, and magic numbers of protons or neutrons was ascertained. (tr-auth)

13062 DECAY SCHEME AND MATRIX ELEMENTS FOR THE β TRANSITION $Cs^{134} \rightarrow Ba^{134}$. H. Daniel, J. Huefner, and O. Mehling (Max-Planck-Institut für Kernphysik, Heidelberg). Ann. Physik (7), 12: 106-12(Oct. 1963). (In German)

The β decay $Cs^{134} \rightarrow Ba^{134}$ was investigated with a double-focusing β spectrometer and a $\beta-\gamma$ circular-polarization correlation setup. The asymmetry parameter A of the correlation between the 656-kev β group and the following γ cascade was measured to be $A = -0.13 \pm 0.02$, in good agreement with a value of Mann, Bloom, and Nagel. This A value implies a ratio X between Fermi and Gamow-Teller contributions to the decay of $X = 0.30 \pm \frac{0.04}{0.05}$ and so a definitely nonvanishing Fermi matrix element. The breakdown of the isotopic spin selection rule at an atomic number as large as that of Cs ($Z = 55$) is not surprising. The β transition is qualitatively discussed in shell model terms. Additional information is given for the disintegration scheme of Cs^{134}. The level scheme of Ba^{134} is discussed in terms of the vibrational model. (auth)

13063 NUCLEAR RESONANCE FLUORESCENCE IN MEV REGION WITH NEUTRON-CAPTURE RADIATION. Hans H. Fleischmann (Technische Hochschule, Munich). Ann. Physik (7), 12: 133-55(Nov. 1963). (In German)

After theoretical reflection on the feasibility of nuclear resonance fluorescence measurements with (n,γ) spectra, some experimental results are reported. A strong intensity was shown in the scattering of neutron-capture spectra from mercury on mercury at 5.4 Mev, which can only be explained by a chance overlapping of a line of the capture spectrum, probably the well-known 5.44-Mev line, with a previously unknown nuclear energy level of a mercury isotope. Also for the scattering of cadmium spectra on lead at 5.2 Mev, such a chance coincidence appeared. The energy absorption cross section for this resonance was measured and from that a lower limit for the ground transition width of the struck level of 0.15 ± 0.03 ev or 0.9 ± 0.4 ev was derived. A negative result for a measurement of the double resonance scattering of reactor spectrum on lead largely excluded the existence of a level over 100 ev in width in the energy region from 4 to 7 Mev. (tr-auth)

13064 THE DEPTH OF THE NUCLEON-NUCLEUS OPTICAL POTENTIAL. B. Mulligan (Massachusetts Inst. of Tech., Cambridge). Ann. Phys. (N. Y.), 26: 159-80 (Feb. 5, 1964).

A correction term to the depth of the local optical potential derived by Kerman, McManus, and Thaler is obtained. This contribution results from improvements in the procedure by which the nonlocal potential is approximated by a local one. Numerical estimates of this term are made, demonstrating that its inclusion gives a better agreement with experiment. Also obtained and compared with the experiment are expressions for the asymptotic values of the real and imaginary parts of the local nucleon-nucleus potential as the energy of the incident particle becomes large. (auth)

13065 RESEARCH IN NUCLEAR FISSION. James E. Gindler (Argonne National Lab., Ill.). Argonne Natl. Lab. Rev., 1: 3-15(Jan. 1964).

A brief review of experimental results on nuclear fission is presented. Fission probability, spontaneous fission, mass distribution, stability of heavy mass peak, asymmetric versus symmetric fission, fine structure in mass distributions, ternary fission, radiochemical data on charge distributions, and angular distributions of fission fragments are discussed. Twenty-eight references are cited. (C.E.S.)

13066 MEASUREMENT OF THE RESONANCE STRUCTURE PARAMETERS OF THE CROSS SECTION STRUCTURE OF SOME ELEMENTS IN THE 0.3 TO 2.7-Mev NEUTRON ENERGY REGION. M. N. Nikolaev and V. V. Filippov. At. Energ. (USSR), 15: 493-8(Dec. 1963). (In Russian)

The parameters that characterize the resonance structure of the cross section must be taken into account when determining the passage of fast and epithermal neutrons through matter. The average values of $1/\Sigma$ and $1/\Sigma^2$ (where Σ designates the macroscopic total cross section) can be calculated only if the whole course of the cross section curve within the energy region of interest is known; in the absence of such values, semiempirical estimates are used in the high-energy region. Using the previous studies on this subject (Atomnaya Energ. 11, 445 (1961)), a computation method, which is applicable for such calculations, was derived. The method was used for determining the total cross section structure of Mg, Al, P, S, Fe, Cu, Ni, Zr, Nb, Pb, and Bi. It was found that in the intermediate atomic-weight region up to Nb and also in the case of Pb and Bi, the cross section exhibits a resonance structure within the energy range examined, while in the case of Mo, Th, and U no such resonance structure was found. The total cross section values of the 3 latter elements agreed with the data reported in the compilation of D. Hughes and R. Schwartz. (TTT)

13067 DEPENDENCE OF THE BACK-SCATTERING COEFFICIENT OF THE β-RADIATION AND THE β-PARTICLE YIELD OF A THICK-LAYER SOURCE ON THE ATOMIC NUMBER OF THE MATERIAL. F. K. Levochkin and Yu. Ya. Sokolov. At. Energ. (USSR), 15: 506-8(Dec. 1963). (In Russian)

The number of β particles emitted in unit time from a unit surface of a thick-layer source having unit specific activity (N_0) must be determined to enable radiometric studies to be carried out. In connection with such measurements, the back-scattering coefficient of a thick-layer source was determined by measuring the total charge transferred from the source to the absorber by the β particles. The thick layer $Sr^{90} + Y^{90}$ sources contained in Al or Pb emitted about 1×10^7 β particles/sec; the number of the particles, N, with a free path terminating the absorber, was measured in a vacuum chamber on the basis of the current between the source and the absorber. The back-scattering coefficient was calculated for C, Al, Cu, Cd, Sn, W, and Pb. After calculating the β yield, it was found that the yield of this radiation emitted by a thick layer source is only slightly dependent on the order number. It was also found that $n_0 \cong Qd$, where q = the specific activity of the source in microcurie/kg and d = half thickness layer for the β particles in Al, in mg/cm^2. This relation was found to be valid within 30% for any source material. (TTT)

13068 INVESTIGATIONS OF THE $Mg^{25}(d,\alpha)Na^{23}$ NUCLEAR REACTION. O. Hansen, E. Koltay, and B. Madsen (Universitet, Copenhagen). At. Kozlemen., 5: Suppl. to No. 3-4, [Paper 1] 10p.(1963).

The correlation between the total cross section for $Mg^{25}(d,\alpha)$ reactions to definite states in Na^{23} and the spin I of these states was investigated experimentally. Bombarding energies from 3.35 to 3.70 Mev and from 7.1 to 7.7 Mev were employed. In the latter region the total cross sections, when averaged over bombarding energy, were observed to be approximately proportional to (2I + 1). This empirical relation is used to deduce the spin values for 7 excited states in Na^{23}. The interpretation based on the rotational model at the Na^{23} level scheme is briefly discussed. From the quantitative evaluation of the observed fluctuations of Ericson's type the averaged width of the excited compound nucleus were obtained. (auth)

13069 STUDY OF ANGULAR DISTRIBUTION OF T-He^3 REACTION. B. Kuehn and B. Schlenk. At. Kozlemen., 5: Suppl. to No. 3-4, [Paper 2] 8p.(1963). (In Russian)

The angular distributions of charged particles for all channels of the reaction He^3 + T were investigated at triton energies of 460, 665, 900, and 1087 kev. The distributions were not isotropic and fluctuated with energy. On the basis of the angular distributions and the correlation between reaction channels, the total cross section for the reaction and the cross section for each separate channel were obtained. (tr-auth)

13070 INVESTIGATION OF THE ENERGY DEPENDENCE OF THE ISOMERIC CROSS-SECTION RATIOS. J. Bacsó, Gy. Csikai, and A. Daróczy (Inst. of Nuclear Research, Hungarian Academy of Sciences, Debrecen). At. Kozlemen., 5: Suppl. to No. 3-4, [Paper 4] 8p. (1963). (In Russian)

The ratio of the cross section for ground- and isomeric-state production in the reactions $Rh^{103}(n,\gamma)Rh^{104}$, $In^{115}(n,\gamma)In^{116}$, and $Br^{81}(n,2n)Br^{80}$ are investigated as a function of bombarding energy. (C.E.S.)

13071 EXPECTED α-DECAY DATA OF THE RARE EARTH NUCLIDES ON THE BASIS OF DIFFERENT SYSTEMATICS. T. Fényes (Inst. of Nuclear Research, Hungarian Academy of Sciences, Debrecen) and Z. Boedy. At. Kozlemen., 5: Suppl. to No. 3-4, [Paper 6] 17p.(1963).

The α-decay data of rare earth nuclides are summarized. The presently existing experimentally measured α- and β-decay energies allow the computation of the decay energy of some 30 further nuclides. By plotting the α-decay energy vs. atomic number, the expected α-decay energy of nuclides, the α-activity of which has not yet been detected experimentally, was estimated. The estimation of the α-decay energies for the above nuclides on the basis of the available mass data as well as p and n separation energies was also performed. The expected α-partial half-lives were also estimated from the gained α-decay ener-

gies using a semiempirical relation expressing explicitly the dependence of the half-life on the atomic number. Finally, some questions about the possibility of experimental detection of the α-activities not yet measured are discussed. (auth)

13072 MEASUREMENT OF ISOMERIC CROSS SECTION RATIO FOR THE $Cs^{133}(n,\gamma)Cs^{134,134m}$ REACTION. Imre Gulyás and Zoltán Zámori. At. Kozlemen., 11: 427-37(1963). (In Hungarian)

The population ratio of the 4^+ spin ground state and the 8^- spin, 137-kev isomeric state in Cs^{134} nuclei produced by the activation of Cs^{133} exposed to reactor neutrons was determined. The measured value of the ratio permits one to draw conclusions on the angular momentum distribution of the highly excited states in Cs^{134}. (auth)

13073 USE OF THE WEIGHTED LEAST SQUARED METHOD FOR EVALUATING THE ANGULAR DISTRIBUTION OF γ-RADIATION. Borbála Gellai. At. Kozlemen., 11: 449-59(1963). (In Hungarian)

Newton's radical determination method, in lack of initial values, could not be conveniently used for the solution of the problem. In the method presented the graphically obtained initial values are treated by Newton's iteration method and lead to the values expected. (auth)

13074 SPIN-PARITY COMBINATIONS OF LEVELS IN Mg^{24} BELOW 9.6-Mev EXCITATION. B. Hird, J. A. Kuehner, E. Almqvist, and C. Brassard (Chalk River Nuclear Labs., Ont.). Can. J. Phys., 42: 153-63(Jan. 1964). (AECL-1849)

Alpha spectra from the reaction $C^{12}(O^{18},\alpha)Mg^{24}$ were examined at 0, 3, and 15° with a magnetic spectrometer at a number of bombarding energies between 22 and 24 Mev. The parities of all the levels in Mg^{24} up to and including the 9.517-Mev level are established as $(-)^J$ with the following exceptions: 5.224, 7.746, 7.808, 8.864, and 9.456 Mev, which are probably $(-)^{J+1}$. Further implications of these measurements on spin and parity assignments are discussed. (auth)

13075 MASS SPECTROMETRIC MEASUREMENTS OF THE HALF-LIVES OF Kr^{87}, Kr^{88}, Xe^{135}, AND Xe^{138}. W. B. Clarke and H. G. Thode (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 42: 213-17(Jan. 1964).

The methods for producing the isotopes and the decay curves are discussed for mass spectrometric measurements of the half lives of Kr^{87}, Kr^{88}, Xe^{135}, and Xe^{138}. (C.E.S.)

13076 THE GAMMA BRANCHING RATIO OF Kr^{85}. T. A. Eastwood, F. Brown, and R. D. Werner (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 42: 218-20(Jan. 1964). (AECL-1869)

The beta-decay rate and the gamma branching ratio of Kr^{85} were determined. The branching ratio was found to be (0.431 ± 0.017)%. (C.E.S.)

13077 MEASUREMENT OF THE CIRCULARLY POLARIZED $\beta-\alpha$ CORRELATION IN THE $2^- \rightarrow 2^+$ TRANSITION OF K^{42}. Paul de Saintignon, Marc Chabre, and Pierre Depommier (Universite, Grenoble, France and Centre d'Etudes Nucleaires, Grenoble, France). Compt. Rend., 258: 884-6(Jan. 20, 1964). (In French)

The degree of circular polarization, $P(\theta_{\beta\gamma})$, of the 1.52-Mev gamma following the first-forbidden, non-unique ($2^- \rightarrow 2^+$) beta transition in K^{42} was measured for different falues of $\theta_{\beta\gamma}$. (tr-auth)

13078 ON THE PRODUCTION OF NUCLEAR ORIENTATION IN Zn^{67}, Cd^{111} AND Cd^{113} BY OPTICAL PUMPING. Jean-Claude Lehmann and Jean Brossel (Ecole Normale Superieure, Paris). Compt. Rend., 258: 869-72(Jan. 20, 1964). (In French)

An analysis of optical pumping, by which nuclear orientation of Hg^{197}, Hg^{199}, and Hg^{201} was previously obtained, is presented. Results on attempted orientation of Zn^{67}, Cd^{111}, and Cd^{113} by optical pumping are discussed in terms of the analysis. Orientation was readily observed in Cd^{111} and Cd^{113}, but was not observed in Zn^{67}. (D.C.W.)

13079 A HYDRODYNAMIC MODEL OF THE RADIOACTIVE DECAY PROCESS. Gyoergy Somogyi and Gyula Szabó (Lajos Kossuth Univ., Debrecen, Hungary). Fiz. Szemle, 13: 189-92(June 1963). (In Hungarian)

No simple quantitative model has as yet been used for representing the many physical processes, including the radioactive decay and the absorption of radiation passing through matter, which follow the exponential law; therefore, 2 hydrodynamic models were developed to illustrate these phenomena. The capillary model, based on the flow of a liquid from a cylindrical vessel with vertical wall through a long horizontal capillary, illustrates very well the radioactive decay. The half life, illustrated by the decrease of the liquid level to the half of its original height, may be adjusted at will by using capillaries of varying lengths; addition of a rubber hose at the end of the capillary tube may serve to mock up secular and transient equilibria. The second system involves the use of a vessel with a curved lateral surface, defined by the Toricelli equation; the decay process is simulated by measuring the amount of liquid flowing out of the vessel through an orifice. Fabrication is difficult because of the complex curved surface but if care is taken, valid quantitative data may be obtained. Both models were found to be useful in teaching. (TTT)

13080 NUCLEAR SPIN-SPIN COUPLING INVOLVING HEAVY NUCLEI. THE COUPLING OF Tl^{205} AND Tl^{203} WITH H^1 NUCLEI IN $(CH_3)_2TlX$ AND $(CH_3CH_2)_2$ TlX COMPOUNDS. J. V. Hatton (National Research Council, Ottawa). J. Chem. Phys., 40: 933-6(Feb. 15, 1964).

The nature of the spin-coupling interaction between thallium nuclei and protons in $(CH_3)_2TlX$ and $(CH_3CH_2)_2TlX$ compounds was examined. In aqueous solution where the corresponding cations R_2Tl^+ are present, the coupling constants are characteristic of the alkyl group attached to thallium. In pyridine solution the coupling constants are dependent upon the nature of X and are larger than those in the parent cation. Using a simplified model for contact interaction employing optical hyperfine splitting constants, an estimate of the contact contribution to the total thallium-proton coupling constant was made for the series R_3Tl, R_2Tl^+, and RTl^{++}. It is found that irrespective of the nature of R the observed proton–thallium coupling constants increase from left to right in the relative proportions predicted by the model. The results are consistent with the conclusion that the thallium and hydrogen nuclei are coupled mainly through the Fermi contact interaction. (auth)

13081 ROLE OF MULTIPLE QUANTUM TRANSITIONS IN NMR: A THREE-SPIN SYSTEM. J. I. Musher (Weismann Inst. of Science, Rehovot, Israel and Rockefeller Inst., New York). J. Chem. Phys., 40: 983-90 (Feb. 15, 1964).

The double and triple quantum (DQ and TQ) transitions in molecules containing three weakly coupled nuclei of spin ½ are examined theoretically and experimentally. Owing to the rapid growth and saturation of these transitions with increasing rf, it is practicable to observe each individual resonance only within a limited rf range. Based on the theory of Yatsiv, expressions at a given $T_1 = T_2$ are com-

puted for the rf fields at which the various MQ absorption signals will attain their maxima and the intensity of these absorptions relative to the maximum intensity for SQ signals. It is pointed out that the usual MQ signal measured in liquids has a linewidth almost equal to that of a SQ signal, since a considerable saturation of the former is necessary for its easy observation. A frequency shift only significant for high-rf MQ signals is also computed. The DQ spectrum of a camphor derivative containing three weakly coupled protons was examined and the experimental results for the observable peaks agree rather well with the theory. The geminal J is opposite in sign to the vicinal J's. (auth)

13082 HALF-LIVES OF ^{83}Y AND ^{83}Sr. I. Dostrovsky, S. Katcoff, and R. W Stoenner (Brookhaven National Lab., Upton, Ill.). J. Inorg. Nucl. Chem., 26: 209-11(Feb. 1964).

Yttrium-83 was produced by the spallation of silver with 30-Gev protons and also by the $Sr^{84}(p,2n)Y^{83}$ reaction with 39-Mev protons. The half life of Y^{83} was determined by means of successive Sr^{83} daughter separations, and a value of 7.4 ± 0.1 min was obtained. In these experiments the half life of Sr^{83} was re-determined as 32.4 ± 0.2 hr. (auth)

13083 HALF LIFE OF ^{135}Sb AND EVIDENCE ON THE HALF LIFE OF ^{134}Sb. C. E. Bemis, G. E. Gordon, and C. D. Coryell (Massachusetts Inst. of Tech., Cambridge). J. Inorg. Nucl. Chem., 26: 213-18(Feb. 1964).

A search for delayed-neutron percursors among the short-lived antimony fission products was unsuccessful. This result suggested that either the neutron branching of the possible precursors Sb^{134} and Sb^{135} is extremely small or that the half lives of those isotopes are much shorter than the upper limits previously reported (45 and 24 sec, respectively). Results of milking experiments in which iodine activity grown from antimony samples separated quickly after neutron irradiations of uranium was counted give the half life of Sb^{135} as $1.9^{+0.5}_{-0.3}$ sec and an upper limit of 1.5 sec for that of Sb^{134}. It is suggested that the ~45 sec antimony fission product, previously ascribed to Sb^{134} or Sb^{135}, may be an isomer of Sb^{132}. (auth)

13084 SEARCH FOR A SPONTANEOUS FISSION BRANCH IN A METASTABLE STATE OF ^{244}Cm. R. Vandenbosch, P. R. Fields, S. E. Vandenbosch, and D. Metta (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 26: 219-34(Feb. 1964).

The partial spontaneous fission half life of the 0.034 sec (I = 6+) metastable state of Cm^{244} was found to be $\geq 1.4 \times 10^2$ years. The lifetime is not reduced as much as might be expected from the 1.04 Mev excitation energy of the isomeric state. This hindrance may be due to the intrinsic structure of the metastable state. The relative thermal neutron capture cross-section ratio for producing the two Am^{244} isomers from Am^{243} was found to be $\sigma(26\ \text{min}\ ^{244m}\text{Am})/\sigma(10.1\ \text{hr}\ ^{244}\text{Am}) = 18.6 \pm 1.9$. (auth)

13085 APPLICATION OF THE PROJECTION METHOD TO THE CALCULATION OF ELECTROMAGNETIC TRANSITIONS. Rouhaninejad Houchang (Centre National de la Recherche Scientifique, Strasbourg). J. Phys., 24: 705-8 (Oct. 1963). (In French)

By considering the Nilsson eigenfunctions and projecting them on eigenstates of total angular momentum, in the case of heavy odd nuclei, formulas were established for the electromagnetic multipole transition probabilities. These results were applied to the electric dipole K forbidden transitions. Agreement with experiment appeared to be satisfactory. (auth)

13086 NOTE ON THE β-γ DIRECTIONAL CORRELATION OF Rb^{86}. J. P. Deutsch, L. Grenacs, and P. Lipnik (Université, Louvain, Belg.). J. Phys., 24: 724(Oct. 1963). (In French)

Some of the results on β-γ directional correlation of Rb^{86} reported previously (J. Phys. Radium, 22: 659, (1961)), are discussed. Taking into account corrections, a somewhat modified value was obtained. (auth)

13087 PERTURBATIONS OF THE γ-γ ANGULAR CORRELATIONS IN THE DE-EXCITATION OF Ho^{166} AND Re^{186}. J. Vervier (Centre d'Étude de l'Énergie Nucléaire, Mol, Belg.). J. Phys., 24: 763-5(Oct. 1963). (In French)

Gamma-gamma angular correlations in the 1380 to 80 kev cascade in the de-excitation of Ho^{166}(27 hr) and in the 631 to 137 kev cascade in the de-excitation of Re^{186} (89 hr) were measured. Results are presented in tables and graphs. (M.C.G.)

13088 NUCLEAR DATA ON GAMMA-RAY EMISSION IN FAST NEUTRONS INTERACTIONS (ALUMINUM). F. W. Krueger (VEB Atomkraftwerk, Betriebsteil, Berlin). Kernenergie, 6: 672-9(Dec. 1963). (In German)

A compilation of nuclear data for production of gamma radiation by exchange effects with fast neutrons is being made. As an example of the arrangement of values, data for aluminum are given. References for the nuclear data are given. (M.C.G.)

13089 STUDY BY THE MÖSSBAUER EFFECT OF THE FARADAY EFFECT IN THE VICINITY OF THE Fe^{57} ABSORPTION LINE. P. Imbert (Centre d'Etudes Nucléaires, Saclay, France). Phys. Letters, 8: 95-6(Jan. 15, 1964). (In French)

Gamma rays from a Co^{57} source were polarized by absorption in iron enriched in Fe^{57} and magnetized transversely. The gamma rays then passed through a dispersion medium (enriched Fe foil with a longitudinal field H) and an analyzer (transversely magnetized Fe foil). The minimum intensity observed by a counter after the analyzer shifted equally and oppositely about that observed with no dispersion medium when the medium was subjected to fields H of opposite direction. The polarization plane was rotated about 14°, twice that obtained by calculations. (D.C.W.)

13090 THE γ-ABSORPTION CROSS SECTION OF HOLMIUM IN THE DYNAMIC COLLECTIVE THEORY. M. Danos (National Bureau of Standards, Washington, D. C.) and W. Greiner. Phys. Letters, 8: 113-15(Jan. 15, 1964).

The collective model, including rotations and surface vibrations, is shown to completely describe the photon absorption cross section for heavy nuclei, and some evidence for the excitation of vibrational giant resonance satellites is given. Previous results for $Ho^{165}(\gamma,2n)$ are given. (R.E.U.)

13091 PHOTODISINTEGRATION OF H^3. R. Boesch, J. Lang, R. Mueller, and W. Woelfli (Eidgenossische Technische Hochschule, Zurich). Phys. Letters, 8: 120 (Jan. 15, 1964).

Cross section measurements for $H^3(\gamma,n)H^2$ from threshold (6.26 Mev) to 9 Mev are reported. (R.E.U.)

13092 THE GROUND STATE CONFIGURATION OF Nb^{92}. R. K. Sheline (Florida State Univ., Tallahassee), C. Watson, and E. W. Hamburger. Phys. Letters, 8: 121-4(Jan. 15, 1964).

The ground state giving rise to a sextuplet of levels at angular momenta and parity of 2^+, 3^+, 4^+, 5^+, 6^+, and 7^+ was investigated using the $Nb^{93}(d,t)Nb^{92}$ pickup reaction. (R.E.U.)

13093 FURTHER EVIDENCE FOR AN EXCITED STATE OF THE ALPHA PARTICLE. P. G. Young and G. G. Ohlsen (Australian National Univ., Canberra). Phys. Letters, 8: 124-6(Jan. 15, 1964).

The proton spectra from the bombardment of He^3 with deuterons were studied in an attempt to verify a 0^+ state in He^4 near 20.1 Mev. (R.E.U.)

13094 THE $Li^6(p,He^3)He^4$ REACTION IN THE ENERGY RANGE 3-5.6 Mev. U. Fasoli, D. Toniolo, and G. Zago (Università, Padua and Istituto Nazionale di Fisica Nucleare, Padua). Phys. Letters, 8: 127-8(Jan. 15, 1964).

Angular distributions and cross sections were measured. The width of the Be^7 10-Mev level is shown to be small for alpha emission. (R.E.U.)

13095 EXCITATION OF M1 TRANSITIONS IN Li^6 AND N^{14} BY INELASTIC ELECTRON SCATTERING. G. R. Bishop (Ecole Normale Supérieure, Orsay, France). Phys. Letters, 8: 128-31(Jan. 15, 1964).

The exchange of entirely transverse virtual photons in the excitation of magnetic transitions by inelastic electron scattering is discussed. The ground- and excited-state wave functions for Li^6 and N^{14} are determined from nuclear properties. The results for N^{14} are given as functions of incident energy and scattering angle for the 2.312-Mev state. (R.E.U.)

13096 THE LOW-LYING LEVELS IN Nb^{92} AND THE GROUND STATE OF Nb^{93}. R. F. Sweet, K. H. Bhatt and J. B. Ball (Oak Ridge National Lab., Tenn.). Phys. Letters, 8: 131-3(Jan. 15, 1964).

The $Nb^{93}(p,d)Nb^{92}$ reaction at E_p = 22 Mev was used to study the level structure of Nb^{92}. Energy level spin assignments are given. (R.E.U.)

13097 EMISSION OF Li^8 FRAGMENTS IN THE INTERACTIONS OF PROTONS AT 14 Gev WITH NUCLEI OF IONOGRAPHIC EMULSIONS. G. Baumann, H. Braun, and P. Cueer (Centre de Recherches Nucléaires, Strasbourg). Phys. Letters, 8: 146-8(Jan. 15, 1964). [In French]

The fragments were produced with a frequency of about 1.5%. Analysis of the number of branches shows that most of them come from heavy nuclei. An attempt to fit the fragment energy spectrum by evaporation theory showed that fragments with energies <10 Mev and >40 Mev were more important than the theory predicted. Further hypotheses permitted an explanation of emission at average energies. Direct proton-substructure interaction is excluded. The energetic fragments are apparently emitted in close correlation with the cascade. (D.C.W.)

13098 ANALYTICAL PROPERTIES AND NONPERTURBATIVE CALCULATION OF THE OPTICAL POTENTIAL FOR NUCLEAR MATTER. A. S. Reiner (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev., 133: B1105-17(Mar. 9, 1964).

Within the framework of Green's functions techniques a definition is discussed of the optical potential in terms of the self-energy of a particle. A theoretical expression for this potential is given based on a version of the independent pair approximation for nuclear matter. Identical dispersion relations are shown to be valid for both the exact and the approximated self-energy. A discussion is presented regarding the relation between the independent pair approximation and the impulse approximation. The region of validity for the latter was estimated. Quantities related to the self-energy, spectral function, and optical potential for a particle above the Fermi sea were calculated for a given nuclear force. Tolerable agreement with experiment is obtained for the real part of the optical potential. Reasons why only the trend of the imaginary part is reproduced can be partly understood. An effective mass approximation is shown to be valid for a wide range of particle and hole energies. A discussion of related approaches is presented. (auth)

13099 ENERGY GAP IN NUCLEAR MATTER. I. EXTENDED THEORY. E. M. Henley and L. Wilets (Univ. of Washington, Seattle). Phys. Rev., 133: B1118-31(Mar. 9, 1964).

The Bogoliubov condition of compensation of dangerous diagrams is invoked to derive a generalized energy-gap equation of the BCS form, but with a renormalized pairing interaction and renormalized single-particle energies. The second-order contributions to the renormalized pairing interaction are found to be significant, contrary to popular belief. It is stressed that the self-consistent solution of the energy-gap equation yields qualitatively and quantitatively different results than a perturbative evaluation of the energy spectrum following a Bogoliubov-Valatin transformation characterized by the lowest order BCS gap parameters. The dependence of the energy gap on high-order corrections is studied in one and three dimensions for simple potentials; for some values of the potential parameters, no solution to the gap equation exists. Finally, the energy gap is studied in nuclear matter. The scattering in both singlet and triplet states of particle-hole pairs, which can be neutron-neutron, neutron-proton, or proton-proton, is included. The interaction is taken to be a sum of separable potentials that reproduce the s-wave phase shift. Because of the short-range repulsion that is included, an infinite set of particle-particle diagrams that replaces the second-order potential vertices by T matrices is summed. The higher order effects studied increase the energy gap by a large factor, especially when the lowest order BCS gap is calculated to be small. Nevertheless, the qualitative conclusion remains that the energy gap in infinite nuclear matter appears to be considerably smaller than that in the heaviest nuclei. (auth)

13100 ENERGY GAP IN NUCLEAR MATTER. II. BCS THEORY. R. Kennedy, L. Wilets, and E. M. Henley (Univ. of Washington, Seattle). Phys. Rev., 133: B1131-7 (Mar. 9, 1964).

The Bardeen-Cooper-Schrieffer (BCS) theory is employed to study the energy gap in nuclear matter with various internucleonic potentials that fit singlet low-energy scattering data and the s-wave phase shift at 310 Mev. The interactions are expressed as the sum of two terms, each of which is separable, thus admitting exact solutions of the energy-gap equation. The dependence of the energy gap on the form and parameters of the interaction, as well as on the nuclear density and effective mass, is investigated. For normal nuclear density, the gap is found to be small compared with that observed in the heaviest nuclei. (auth)

13101 NUCLEAR SPINS AND HYPERFINE-STRUCTURE SEPARATIONS OF SILVER-112 AND SILVER-113. Yau Wa Chan, W. Bruce Ewbank, William A. Nierenberg, and Howard A. Shugart (Univ. of California, Berkeley). Phys. Rev., 133: B1138-44(Mar. 9, 1964). (UCRL-10970)

The nuclear spins and the hyperfine-structure separations in the $^2S_{\frac{1}{2}}$ electronic ground state of two silver isotopes, 3.2-h Ag^{112} and 5.3-h Ag^{113}, were measured by the atomic-beam magnetic-resonance method. Combining these measurements with the known constants of Ag^{109}, the corresponding nuclear magnetic-dipole moments were calculated. (auth)

13102 SHAPE OF THE POSITRON SPECTRUM OF Rb^{84}. L. M. Langer, E. H. Spejewski, and D. E. Wortman (Indiana Univ., Bloomington, Ind.). Phys. Rev., 133: B1145-9(Mar. 9, 1964).

The shape of the positron distribution in the decay of Rb^{84} was studied in a magnetic spectrometer. Using both

proportional counter and solid-state detectors, it was possible to obtain data that permitted the subtraction of the outer group from the total spectrum without obliterating the subtle details of the inner group. The outer group is fitted very well with the unique once forbidden shape factor. However, an additional empirical factor of $1 + 0.2/W$ yields an even better fit to the data. The inner group has a distribution that is slightly but measurably different from the statistical shape. This shape cannot be accounted for by an empirical factor of the form $1 + b/W$ alone. The endpoint energies are found to be 1.657 ± 0.003 and 0.780 ± 0.006 Mev, in good agreement with the weighted average of 0.880 Mev for the gamma ray between the first excited and ground states of Kr^{84}. (auth)

13103 PHOTONEUTRON CROSS SECTIONS FOR NATURAL Cu, Cu^{63}, AND Cu^{65}. S. C. Fultz, R. L. Bramblett, J. T. Caldwell, and R. R. Harvey (Univ. of California, Livermore). Phys. Rev., 133: B1149-54(Mar. 9, 1964). (UCRL-7482)

Using monochromatic gamma rays obtained from the annihilation-in-flight of fast positrons, the (γ,n) and $(\gamma,2n)$ cross sections for samples of natural Cu, Cu^{63} enriched to 99.3%, and Cu^{65} enriched to 99.7% were measured. The (γ,n) cross sections for natural Cu, Cu^{63}, and Cu^{65} were found to have maximum values of 71 ± 7, 70 ± 7, and 75 ± 7 mb, respectively, while the maximum $(\gamma,2n)$ cross sections are 15.4 ± 2, 13.5 ± 1, and 28 ± 3 mb, respectively. The corresponding values for the (γ,n) integrated cross sections up to 28 Mev are 525 ± 52, 523 ± 52, and 437 ± 43 Mev-mb, and the $(\gamma,2n)$ integrated cross sections are 110 ± 11, 80 ± 8, and 195 ± 19 Mev-mb. (auth)

13104 POLARIZATION OF PROTONS FROM DEUTERON STRIPPING REACTIONS. L. H. Reber and J. X. Saladin (Univ. of Pittsburgh). Phys. Rev., 133: B1155-61 (Mar. 9, 1964).

The proton polarization angular distributions from the following reactions were measured: $C^{12}(d,p)C^{13*}$(3.09 Mev, $l_n = 0$); $Mg^{24}(d,p)Mg^{25}$(g.s., $l_n = 2$, and 0.58 Mev, $l_n = 0$); $Be^9(d,p)Be^{10}$(g.s., $l_n = 1$, and 3.37 Mev, $l_n = 1$); $Si^{28}(d,p)Si^{29*}$ (1.28 Mev, $l_n = 2$). The incident deuteron energy was 15 Mev. Carbon and helium were used as polarization analyzers. The results are discussed in terms of distorted-wave theory. In addition to the polarization measurements, the differential cross section of deuterons elastically scattered from aluminum, silicon, and beryllium was determined. (auth)

13105 SECOND-ORDER COULOMB EXCITATION VIA THE GIANT DIPOLE RESONANCE. Joerg Eichler (California Inst. of Tech., Pasadena). Phys. Rev., 133: B1162-5 (Mar. 9, 1964).

The contributions to the Coulomb excitation probability due to virtual electric dipole transitions into the giant resonance were studied. Use was made of the fact that the second-order transition amplitude can be related to the photonuclear absorption cross section that is known experimentally. Two examples are discussed in some detail: The Coulomb excitation of a first-excited 0^+ level from a 0^+ ground state; second-order corrections to a $0^+ \rightarrow 2^+$ transition. In the latter case, the corrections are of the same order of magnitude as those due to the reorientation effect that was proposed as a means to measure the quadrupole moment of excited states. (auth)

13106 RECOIL STUDY OF THE $Zn^{68}(p,2p)Cu^{67}$ REACTION. David L. Morrison and Albert A. Caretto, Jr. (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 133: B1165-70(Mar. 9, 1964).

The excitation function and the product recoil behavior of the $Zn^{68}(p,2p)Cu^{67}$ reaction was studied using incident protons of energy between 80 and 430 Mev. The thick-target thick-catcher technique was used in which effective recoil ranges were measured in the forward, backward, and transverse directions. The data were interpreted in terms of the knock-out mechanism. The data were also fitted to a recoil velocity distribution written in terms of a power series in the cosine of the scattering angle. Ranges calculated by this treatment are consistent with the interpretation that the reaction proceeds mainly by the knock-out mechanism. Reasonable agreement was obtained between the recoil kinetic energy, calculated on the basis of the assumed recoil velocity distribution, and that which would be obtained from an abrupt removal of a proton from the top of the nuclear well in Zn^{68}. (auth)

13107 POLARIZATION AND CROSS SECTION OF PROTONS SCATTERED BY He^3 FROM 4 TO 13 Mev. D. G. McDonald, W. Haeberli, and L. W. Morrow (Univ. of Wisconsin, Madison). Phys. Rev., 133: B1178-82(Mar. 9, 1964). (TID-19445)

The polarization of protons elastically scattered by He^3 was measured at six proton energies between 4 and 13 Mev and center-of-mass angles from 59 to 110°. Additional measurements were made at 133° from 7 to 11 Mev and at 124° at 10.7 Mev. The main feature of the data is the large polarization occurring near 120° for all energies. The maximum polarization measured was $+0.65 \pm 0.06$ at 10.7 Mev and 124°. The maximum polarization measured at 4 Mev was $+0.40 \pm 0.04$ at 110°. Above 8.8 Mev the polarization in the vicinity of 80° is negative and as large as -0.21 ± 0.03 at 12.8 Mev and 77°. The agreement with the 10-Mev measurements of Rosen and Brolley is good. New cross-section data between 4 and 10.8 Mev are also given. (auth)

13108 NEUTRON SPECTRA FROM $Li^7(d,n)Be^8$ AND $F^{19}(d,n)Ne^{20}$ FOR 1.98-Mev DEUTERONS. C. H. Johnson and C. C. Trail (Oak Ridge National Lab., Tenn.). Phys. Rev., 133: B1183-90(Mar. 9, 1964).

The neutron spectrum from $Li^7(d,n)Be^8$ was studied at 120° with respect to the beam of deuteron incident on a lithium metal target. The average deuteron energy in the target was 1.98 Mev. Up to an excitation of 9 Mev in Be^8, only the ground state and the first excited state are observed. The neutron group to the excited state has a peak corresponding to 3.1 ± 0.1-Mev excitation in Be^8 and a width of 1.75 ± 0.1 Mev in the center-of-mass system; however, the interpretation of these numbers in terms of the level parameters is obscured by the presence of a continuum from three-body decay. The relative differential cross section for the neutron groups leaving Be^8 in the ground state and in the first excited state was measured from 0 to 135° and normalized to an absolute value at 0° measured with a LiF target. The cross section for the production of Be^8 in the first excited state has some uncertainty because of the contribution from the competing three-body breakup of the compound system. Cross sections at 0° for $F^{19}(d,n)Ne^{20}$ are also given for reactions leaving Ne^{20} in the ground state and first excited state. (auth)

13109 K^+ MESON PHOTOPRODUCTION FROM COMPLEX NUCLEI. A. J. Sadoff and B. D. McDaniel (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 133: B1200-1(Mar. 9, 1964).

K^+ meson yields were measured from various elements using a bremsstrahlung beam of maximum energy of 1150 Mev. The K^+ mesons were detected using a magnetic spectrometer set at a momentum of 415 Mev/c and laboratory angle of 35°. These kinematical conditions correspond to an angle of 90° in the center of mass and a photon en-

ergy of 1054 Mev for the reaction $\gamma + p \rightarrow K^+ + \Lambda$. The targets used were Be, C, Al, Cu, Ag, W, and Pb. The results show a slight decrease in the yield per proton as a function of atomic number. A crude estimate yields a mean free path in nuclear matter of the order of 10 F for the geometry of this experiment. (auth)

13110 RADIATIVE TAIL IN ELASTIC ELECTRON SCATTERING. L. C. Maximon and D. B. Isabelle (National Bureau of Standards, Washington, D. C.). Phys. Rev., 133: B1344-50(Mar. 9, 1964).

The Bethe-Heitler cross section with arbitrary form factor is integrated over all photon angles, without approximation. The limit of this integrated cross section for large energies ϵ of the initial and final electron is considered in detail. It is shown that the contribution to this cross section from photons emitted in the direction of either the incoming or the outgoing electron gives the terms of order $\ln\epsilon$ found by Schiff, but that the contribution from all other photon directions is of relative order 1, and explicit expressions are given for these terms, as well as a numerical evaluation for some typical cases, since for the energies of experimental interest, viz., 30–1000 Mev, the logarithm is not very large: $\ln\epsilon \approx 4$-8. Furthermore, keeping the terms of order 1 is of particular importance for electron scattering angles, ϑ, near 180°, since, as is shown, the terms in $\ln\epsilon$ all have the factor $\cos^{2}\frac{1}{2}\vartheta$, which is not the case for the terms of order 1. It is shown that all the formulas given are also valid for ϑ equal or very close to 180°. (auth)

13111 NUCLEAR MAGNETIC ANTISHIELDING OF NUCLEI IN MOLECULES. MAGNETIC MOMENTS OF F^{19}, N^{14}, AND N^{15}. Milton R. Baker, Charles H. Anderson, and Norman F. Ramsey (Harvard Univ., Cambridge, Mass.). Phys. Rev., 133: A1533-6(Mar. 16, 1964).

The combination of molecular beam data on spin-rotational interactions in molecules with chemical shift data was used to calculate the paramagnetic part of the nuclear magnetic shielding constant for F in HF and F_2. With the assumption of the sign of the spin-rotational constant in N_2^{15} as positive (i.e., a net negative rotational magnetic field at the nitrogen nucleus), the paramagnetic part of the nuclear magnetic shielding constant in N_2 was calculated. The results, when combined with reliable calculations of the diamagnetic part of the shielding constant, yield the total shielding constants. These are found to be: F in HF: $\sigma = (414.9 \pm 1.4) \times 10^{-6}$, F in F_2: $\sigma = (-210 \pm 8.0) \times 10^{-6}$, N in N_2: $\sigma = (-101 \pm 25.0) \times 10^{-6}$, and demonstrate the phenomenon of nuclear magnetic antishielding in F_2 and N_2, as well as in other compounds. Use of these shielding constants permits considerable improvement in the estimates of the bare nuclear magnetic moments of fluorine and nitrogen. The results are $\mu_N(F) = 2.628353 \pm 0.000005$ nm, $\mu_N(N^{14}) = 0.403562 \pm 0.000010$ nm, $\mu_N(N^{15}) = -0.283049 \pm 0.000007$ nm. (auth)

13112 FAST-NEUTRON SPECTROSCOPY. Lawrence Cranberg. Sci. Am., 210: 79-86; 88(Mar. 1964).

New systems for measuring the velocities of energetic neutrons that have made it possible to extend the use of neutrons as nuclear structure probes are discussed. The spectra of 3.5-Mev neutrons scattered on lead -206, -207, and -208 are discussed, and nuclear shell diagrams are used to illustrate the scattering reactions. (C.E.S.)

13113 COHERENT-SCATTERING AMPLITUDES FOR NEUTRONS AND GALLIUM NUCLEI. Yu. S. Kuz'minov and N. V. Belov (Inst. of Crystallography, Academy of Sciences, USSR). Soviet Phys.-Cryst. (English Transl.), 8: 537-8(Jan.-Feb. 1964).

The neutron coherent scattering amplitude for gallium was deduced in a study of the ferrite $3Y_2O_3 \cdot 3Fe_2O_3 \cdot 2Ga_2O_3$ directed to the determination of the magnetic interactions of the Fe^{3+} ions in the sublattices. (C.E.S.)

13114 SURFACE OSCILLATIONS OF EVEN-EVEN NUCLEI. Hung-tao Shen, Yang-kou Lee, and Gun-wei Jen, Wu Li Hsueh Pao, 16: 132-42(1960). (In Chinese)

The level spectrum of collective surface oscillations of even-even nuclei, especially the effect of β-degree of freedom on the level spectrum in the strong coupling theory, is studied. It appears that, except for the contribution of a series of β-vibration levels, the effect on other levels is small. (auth)

13115 A PRELIMINARY INVESTIGATION ON THE ROTATIONAL ENERGY LEVELS OF Mg^{24}. Hong-chin Shen and Hsiao-tsien Chou. Wu Li Hsueh Pao, 17: 135-42(Mar. 1961). (In Chinese)

The energy, spin, and parity of the Mg^{24} energy levels below 5.24 Mev are accurately known but the parameters of the energy levels above 5.24 Mev are far less accurate. Though the rotational characteristics of Mg^{24} levels are well established, the discrepancy between the experimental value 4.12 Mev and the value 4.6 Mev calculated from the simple rotation energy formula is beyond the limit of experimental uncertainty. There are two kinds of corrections, the rotation-vibration interaction and the rotational perturbation. It is shown that the levels of Mg^{24} can not be explained satisfactorily by taking into consideration either one of the corrections singly. When both are used simultaneously the experimental values of the energy and spin of Mg^{24} levels can be well accounted for, and the recently measured γ-transition branching ratio and E2/M1 ratio can also be explained. (auth)

13116 NUCLEAR REACTIONS AND NUCLEAR STRUCTURE. C. T. Young. Wu Li Hsueh Pao, 18: 75-90(June 1962). (In Chinese)

The methods of studying nuclear structure by means of nuclear reactions as a tool for investigation are reviewed. The review is divided into two parts. The first part is mainly concerned with the properties of the individual low-lying levels of nuclei, a brief outline being given to describe the present situation of cumulation of experimental results and the current theories developed to account for them. The second part reviews the experimental methods tried for studying the virtual states of nuclei. In both parts, typical types of nuclear reactions used in these investigations are described. (auth)

13117 NUCLEAR PHYSICS AND THE FUNDAMENTAL PARTICLES. Harry H. Heckman and Paul W. Starring. New York, Holt, Rinehart and Winston, Inc., 1963. 416p.

An elementary presentation of the nuclear atom, the nucleus, nuclear models and potentials, radioactive nuclei, interactions of radiation in matter, particle accelerators, electronic particle detectors, track-forming detectors, unstable particles, the K mesons and hyperons, antiparticles, space physics and health physics is given. (C.E.S.)

13118 THE HALF-LIFE OF ^{187}Re. B. Hirt (Universität, Bern), G. R. Tilton, W. Herr, and W. Hoffmeister. p.273-80 of "Earth Science and Meteoritics." New York, Interscience Publishers, 1963.

The half life of the natural β-decay of Re^{187} was determined by analyzing ten molybdenite samples of known age by the rhenium-osmium method. The ages of the molybdenite samples were known from radioactive dating of surrounding rocks. A value of $(4.3 \pm 0.5) \times 10^{10}$ years was found for the half life. (auth)

13119 POLARIZATION OF PROTONS ELASTICALLY SCATTERED BY OXYGEN. Richard Arthur Blue. Thesis, Madison, Wis., Univ. of Wisconsin, 1963. 134p.

Measurements of the polarization of protons elastically scattered by O have been made between 2 and 12 Mev by double scattering using gas targets. Scattering by He at 45° was used as the polarization analyzer for most of the work. In addition to the polarization, 4 angular distributions of the cross section were measured between 2.5 and 3.8 Mev. Below 5 Mev the polarization changes slowly with energy except for sharp resonances at 2.66 and 3.47 Mev. At 3.00 Mev the polarization is negative at forward angles and positive at back angles, the observed extreme being -0.14 ± 0.02 at 45° and 0.43 ± 0.03 at 115°. Proton-O scattering exhibits pronounced resonance structure above 5 Mev so that the polarization fluctuates rapidly with energy. Angular distributions of the polarization were measured at energies selected to avoid resonances. At 10.7 Mev the observed extremes in the polarization are -0.88 ± 0.04 at 50°, 0.92 ± 0.04 at 65°, and -0.83 ± 0.03 at 133°. A phase shift analysis of the polarization and cross section data was made between 2 and 5 Mev and at 4 energies between 5 and 7 Mev. Only small changes in the phase shifts obtained by Salisbury were needed to bring the calculated polarizations into agreement with the present results. Angular distributions of the polarization are also compared with the predictions of the optical model between 8 and 12 Mev. Measurements of the polarization for p-He^4 scattering and p-C^{12} scattering between 2 and 4 Mev are included. (M.P.G.)

13120 COMPETITION BETWEEN THE (p,2p) AND (p,pn) REACTIONS IN Cd^{106}. James M. Dwyer. Thesis, Rochester, N. Y., Univ. of Rochester, 1963, 115p.

Radiochemical measurement of (p,2p) and (p,pn) reactions in Cd^{106} from 100 to 400 Mev using enriched isotopes is described. Absolute cross sections measured, in mb, (relative to $Al^{27}(p,p3n)Na^{24}$) were for (p,pn): 180 Mev (7.6), 200 Mev (8.4), 240 Mev (6.0), 300 Mev (6.0), and 400 Mev (5.9, 5.1); and for (p,2p): 180 Mev (1.5), 200 Mev (1.0), 240 Mev (2.8), 300 Mev (9.4), and 400 Mev (7.3, 6.9). Relative (p,2p)/(p,pn) cross sections measured at 120, 160, 200, 240 Mev were $.18 \pm .06$, $.31 \pm .05$, $.20 \pm .06$, $.66 \pm .10$. All (p,pn) cross sections are high due to an unknown contribution believed to be small, from (p,2n) reactions. The small values of the cross sections are discussed in terms of availability of stable hole states in the product nucleus. Detailed description is given of the techniques of electroplating targets and samples and of procedures for absolute counting of K capture in presence of internal conversion. A discussion of the decay scheme of Ag^{105} is given. The intensity of the 64-kev transition was measured as 17.5 per 100 capture events (K + L). It is shown that the 344-kev level is long-lived by absence of 86-kev peak in a SUM spectrum of Ag^{105}. (M.P.G.)

13121 A STUDY OF THE $C^{13}(d,\alpha)B^{11}$ AND $B^{11}(He^3,p)C^{13}$ REACTIONS. Bruce Burton Marsh. Thesis, Rochester, N. Y., Univ. of Rochester, 1963. 87p.

Angular distributions and excitation functions for the $C^{13}(d,\alpha)B^{11}$ and $B^{11}(He^3,p)C^{13}$ ground-state reactions were measured with the view of obtaining information on the mechanism of 2-particle transfer reactions. The 2 cases studied are related in that both involve the transfer of a deuteron between B^{11} and C^{13}. The angular distributions for the $B^{11}(He^3,p)C^{13}$ reaction are typical of a direct process. Two versions of the plane-wave Born approximation, one due to Newns and the other to Macfarlane and French, were used to obtain theoretical fits to the experimental data, and the results were compared. The $C^{13}(d,\alpha)B^{11}$ reaction, on the other hand, was found to proceed through compound nucleus formation. Good fits to the angular distributions were obtained using Legendre polynomials. The presence of an appreciable sixth-order term implies that the $l = 3$ partial wave of the incident beam contributes significantly to the reaction. Since the penetration of this partial wave is small (<2%), the states in the compound nucleus fed by it must be strongly excited. The observed differences in the 2 cases indicate that the overlap of momentum transfer in such related reactions is not a sufficient condition to insure similar reaction mechanisms. (Dissertation Abstr.)

13122 A STUDY OF THE EIGENSTATES OF THE PAIRING-FORCE HAMILTONIAN WITH APPLICATIONS TO SOME ISOTOPES OF LEAD. Robert William Richardson. Thesis, Ann Arbor Mich., Univ. of Michigan, 1963. 161p.

The general structure of the eigenstates of the pairing-force Hamiltonian is considered, and expressions for some particular eigenstates are derived. The study of the structure of the eigenstates is based upon the close similarity between the many-fermion system with pairing forces and the many-boson system with one-body forces, which is obtained from the many-fermion system by replacing each fermion pair with a single boson. It is shown that the only difference between these 2 systems is a set of subsidiary conditions on the many-fermion wave function. The subsidiary conditions are such that they insure the satisfaction of the Pauli principle. The equations for the wave function are shown to be a Schroedinger equation (which is formally the same as that for the many-boson system) plus the set of subsidiary conditions. Two new classes of eigenstates of the pairing-force Hamiltonian can be constructed from the equations, the set of eigenstates of the system that consists of N pairs in 2, multiply degenerate, single-particle levels and a restricted set of eigenstates of N pairs in an arbitrary external potential well. The second new class of eigenstates is applied to some isotopes of Pb. The excitation spectra of Pb^{206} and Pb^{204} are recalculated using pairing-interaction strengths obtained directly from the observed pairing energies. This leads to pairing-interaction strengths of 0.150 and 0.145 Mev for the 2 nuclei considered. These stronger pairing-interaction strengths predict the observed levels of these nuclei with an average error of 0.1 Mev. The use of the exact eigenstates for the description of nuclear spectra is shown to be a considerable improvement over existing approximations. (M.P.G.)

13123 THE ANGULAR DISTRIBUTION OF FAST NEUTRONS SCATTERED FROM BISMUTH. William Hurst Snedegar, Jr. Thesis, Lexington, Ky., Univ. of Kentucky, 81p.

A time-of-flight neutron spectrometer was built for the purpose of examining the neutrons scattered from Bi^{209} in order to evaluate the statistical and optical models for this reaction. The Bi^{209} was cast in the form of a hollow cylinder and bombarded with 2.82 Mev neutrons. The angular distributions of the elastically scattered neutrons and the neutrons scattered inelastically from the 0.895 and the 1.56 Mev levels of Bi^{209} were measured over the angular range of 20° to 130°. The elastically scattered neutrons showed a decided peak in the forward direction, in accordance with an optical-type interaction. In addition, there was definite evidence that an appreciable part of the reactions proceeded by compound elastic scattering, leading to a component symmetric about 90°. Both energy groups of inelastically scattered neutrons were peaked in the for-

ward direction, to an unusually large degree for such relatively low-energy incident neutrons. The conclusion again is that the optical description is proper for the reaction, although some statistical-type symmetry could be concealed under the optical distribution shape. (M.P.G.)

13124 PHOTOPROTON DISTRIBUTIONS FROM CARBON. Holland Douglas Warren. Thesis, Charlottesville, Va., Univ. of Virginia, 1963, 140p.

The angular and energy distributions of photoprotons from C^{12} were measured from 6.75 to 21 Mev proton energies with an E, dE/dx coincidence-counting spectrometer and with 65 Mev maximum γ-ray energy. The spectrometer consisted of a CsI(Tl) crystal as the E detector and a thin silicon p-n junction diode as the dE/dx detector. The E pulse was counted in a 20-channel analyzer, provided analyzer was gated by coincident E, dE/dx pulses. The data were analyzed in 1 Mev intervals, and the least squares method was used to fit the data by the equations $a + b\cos\theta + c\cos^2\theta$ and $a + b\sin^2\theta + A\cos\theta + B\sin^2\theta\cos\theta$, the characteristic equation for electric dipole-electric quadrupole interference in a direct interaction. Calculations showed that the latter equation was a better fit to the data over the entire energy region. The results show the existence of forward asymmetry in the angular distribution for the proton energies measured. The peak of the distribution shifts forward from 75° near 8 Mev to 65° at the higher energies. The experimental angular distribution is consistent with the theoretically predicted distribution for interference between electric dipole and electric quadrupole transitions in a direct interaction. The magnitude of the interference increases with proton energy, reaches a maximum near 16 Mev, then abruptly decreases and remains at a lower value through 21 Mev. Both $\frac{1}{2} \rightarrow \frac{1}{2} + 1$ and $\frac{1}{2} \rightarrow \frac{1}{2} - 1$ transitions from the $1p_{\frac{1}{2}}$ state in C^{12} appear to be present, and there is a possibility of transitions from the $1s_{\frac{1}{2}}$ state in the proton energy region 18 to 21 Mev. The energy spectra show a small resonance at 13 Mev proton energy. (M.P.G.)

13125 THE ATOMIC NUCLEUS. M. Korsunsky. Translated from Russian by G. Yankovsky. New York, Dover Publications, Inc., 1963. 433p. $2.00.

A summary of early theory and experiment in radioactivity is given. The nuclear model of the atom and the mass of nuclei are discussed. Nuclear disintegration, the positron, artificial transformation of nuclei, artificial radioactivity, mesons, the neutrino, nuclear structure, forces acting between nuclear particles, fission, transuranium elements, nuclear chain reactions, reactors, atomic energy, and thermonuclear reactions are also considered. (C.E.S.)

Plasma Physics and Thermonuclear Processes

13126 (AD-403871) INVESTIGATION OF HIGH-POWER GASEOUS ELECTRONICS. First Quarterly Progress Report, November 15, 1962 to February 15, 1963. Harold S. Maddix (Microwave Associates, Inc., Burlington, Mass.). Contract DA-36-039-AMC-00097(E). 27p.

Cleanup and thermal recovery of inert gases at the interface between a high power microwave gas discharge and a quartz surface were investigated. Comparable cleanup and recovery characteristics were observed for argon and krypton gases. Both the total number of atoms sorbed while the discharge was on and thermally desorbed when the discharge was terminated were proportional to the square root of time. Analyses of the data indicate that cleanup and recovery are controlled by activated diffusion processes. (auth)

13127 (AD-413324) INTERACTION OF A RADIATING SOURCE WITH A PLASMA EFFECT OF AN ELECTRO-ACOUSTIC WAVE. Kun-Mu Chen (Michigan. Univ., Ann Arbor. Inst. of Science and Tech.). July 1963. Contract AF33(616)-8365. 35p.

When a radiating source is immersed in a homogeneous plasma of infinite extent, an electroacoustic wave may be excited in addition to the usual electromagnetic wave. The electroacoustic wave becomes a longitudinal plasma wave in the far zone of the source. The case of a Hertzian dipole in a lossless plasma is considered first. The fields of both the electromagnetic and plasma modes excited by the dipole are explicitly obtained, and the electromagnetic and plasma components of the radiation resistance of a Hertzian dipole are determined. The case of a cylindrical dipole antenna in a lossless plasma is investigated next. The far zone fields of both the electromagnetic and plasma modes are explicitly obtained, and the electromagnetic and plasma components of the radiation resistance are then derived as functions of the antenna dimension and the plasma parameters. Finally, the case of a Hertzian dipole in a slightly lossy plasma is studied; the effect of collisions in a plasma on the radiation resistance of the immersed antenna is discussed. (auth)

13128 (AFCRL-63-127) INVESTIGATION OF THE EFFECTS OF HIGH-INTENSITY ELECTROMAGNETIC WAVES ON THE TRANSPORT PROPERTIES AND PHENOMENA OF IONIZED GAS AT ELEVATED TEMPERATURES. Final Report. (Avco Corp. Avco-Everett Research Lab., Everett, Mass.). Apr. 1963. Contract AF19(604)-7458. 59p. (AD-407346)

The experimental and theoretical research performed on the transport properties and phenomena of ionized gases at elevated temperatures is summarized. The papers and reports published under the contract are listed. Abstracts of the reports are included, together with a compilation of the status reports. (D.C.W.)

13129 (AFOSR-4644) RESEARCH ON NON-EQUILIBRIUM PLASMA PHYSICS. Final Technical Report. S. R. Byron and W. W. Lawrence (Aeronutronic. Div. of Ford Motor Co., Newport Beach, Calif.). Jan. 15, 1963. Contract AF49(638)-670. 14p. (AD-406471)

An experimental study of shock waves produced in a T-tube and a theoretical study of electron-ion reaction rates are summarized. Precursor ionization in the T-tube was observed, but no conclusive evidence concerning the source of the ionization was obtained. The study of electron-ion reaction rates resulted in a detailed theory for the rate of three body electron-ion recombination and radiative decay in monatomic gases. Comparison of this theory with published measurements in He, Ar, Hg, and Cs shows very good agreement. (auth)

13130 (ARA-T-9197-7) REFLECTION AND TRANSMISSION OF OBLIQUE HYDROMAGNETIC WAVES AT A PLASMA-VACUUM INTERFACE. Report No. 7, Interim Report. Robert F. Smiley (Allied Research Associates, Inc., Concord, Mass.). Mar. 1963. Contract DA-36-039-SC-89177. 60p. (AD-409734)

The reflection and transmission of oblique plane hydromagnetic waves at the interface between a cold collision-free plasma and a vacuum, where the plasma is permeated by a constant external magnetic field, is investigated theoretically. Wave frequencies are assumed to be small compared to the ion cyclotron frequency. Electric field, magnetic field, and energy ration are evaluated for all reflected

and transmitted waves. The application of these results to the penetration of low frequency hydromagnetic waves through the lower ionosphere is discussed. (auth)

13131 (NASA-TN-D-2118) EFFECT OF SEEDING AND ION SLIP ON ELECTRON HEATING IN A MAGNETOHYDRODYNAMIC GENERATOR. Frederic A. Lyman, Arthur W. Goldstein, and John E. Heighway (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Feb. 1964. 44p.

The influence of electron-ion collisions on the attainment of high electron temperatures and their corresponding effects on conductivity and power density in magnetohydrodynamic generators were examined theoretically. For argon seeded with various small amounts of cesium, it was found that the presence of seed is actually deleterious to electron heating. The maximum electron temperature, conductivity, and power density are attained without seed. The effect of ion slip was also analyzed, and the value of the ratio of magnetic field to gas pressure for maximum power density was determined for unseeded argon. (auth)

13132 (NASA-TN-D-1783) DIRECT VELOCITY MEASUREMENTS IN LOW-DENSITY PLASMA FLOWS. W. D. Beasley, J. D. Brooks, and R. L. Barger (National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.). May 1963. 11p. (N63-15501)

The flow velocity is measured directly in a direct-current arc jet by creating a luminous disturbance in the flow and measuring its time-of-flight over a known distance with photoelectric detectors. This technique is applicable to flows with high stagnation temperatures and low discharge pressures. Measurements made in supersonic flows without arc heating correlated well with velocities computed from pressure probe measurements. Measurements made in supersonic plasma flows exhibited good repeatability at static pressures well below 1 mm Hg. (auth)

13133 (NBS-8212) ON THE CRYOGENIC ASPECTS OF PROJECT SHERWOOD. Progress Report No. 16, October 1, 1963–December 31, 1963. (National Bureau of Standards. Boulder Labs., Boulder, Colo.). Jan. 21, 1964. 13p.

The Fermi surface of niobium was investigated, together with the energy gap for films. The Ginzberg-Landau equations were calculated with a varying magnetic permeability Also, the aluminum magnet was tested to 73.3 kgauss. The measured magnet resistance was considerably higher than the calculated values. No shorting due to axial compressive stress was detected, and no warping or distortion of the coil lobes was observed. A system to provide a high rate of refrigeration for a relatively short time was investigated. Application of the reheat principle to final expansion stages of the high-capacity, steady-state refrigerator of the system seems to offer a performance increase of 15 to 20%. (D.C.W.)

13134 (ORNL-3564) THERMONUCLEAR DIVISION SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING OCTOBER 31, 1963. (Oak Ridge National Lab., Tenn.). Feb. 13, 1964. Contract W-7405-eng-26. 136p.

Separate abstracts were prepared for the nine main sections of the report. Other sections consider preparations for measurements of atomic collision cross sections and design and engineering activities. (D.C.W.)

For abstracts of individual sections see: 12329, 13008, 13135, 13136, 13137, 13138, 13139, 13140, and 13141.

13135 (ORNL-3564(p.1-13)) DCX-1 PLASMA EXPERIMENTS. J. L. Dunlap, R. S. Edwards, G. R. Haste, L. A. Massengill, C. E. Nielsen, Herman Pastma, L. H. Reber, R. G. Reinhardt, W. J. Schill, and E. R. Wells (Oak Ridge National Lab., Tenn.).

A new high-vacuum liner with a circular cross section (radius = 11 in.) was installed and the injection system was slightly altered. Recent experiments defined three characteristic modes of r-f activity and yielded more information about the correlations between several plasma parameters and this activity. The investigations of the effects of adding electron cyclotron heating were resumed. Studies of the properties of plasmas established by Lorentz-force dissociation of H_2^+ were continued and extended to larger injection rates and longer containment times than those previously reported for such plasmas. The details of these experiments and summarizing interpretations in terms of the collective behavior are given. (auth)

13136 (ORNL-3564(p.14-27)) DCX-2. P. R. Bell, L. J. Bledsoe, J. S. Culver, et al. (Oak Ridge National Lab., Tenn.).

Improvements in diagnostic procedures showed that the trapped plasma in DCX-2 is denser than was previously and that there is little loss other than by charge exchange. Typical figures, using a lithium arc as dissociator, are: 2×10^{15} particles trapped, peak density of fast particles 2×10^{10} cm^{-3}; input beam 30 mamp, which is 30% dissociated in the arc; base pressure 10^{-7} torr, seriously modified by arc and plasma pumping. The decay times are about 14 msec—a provisional figure because the shape of the decay curve is not yet understood. There is no slow rotation. Details are given of diagnostic procedures, analysis, plasma pumping, and radio-frequency signals observed under various operating conditions. A hydrogen arc was used as dissociator. (auth)

13137 (ORNL-3564(p.28-43)) ELECTRON-CYCLOTRON HEATING. (Oak Ridge National Lab., Tenn.).

The scale-up of the electron-cyclotron plasma was completed and operated in the EPA facility. The plasma is created in a 3:1 magnetic mirror field by a 10.6-Gc microwave power source capable of delivering 50 kw continuous wave (cw). Preliminary results show that the plasma volume is ~40 l and contains several hundred joules of stored energy with 25-kw, cw microwave power. Other interesting properties of the plasma relevant to the scale-up are described. An experiment involving the measurement of the radial energy density distribution of the ECP was performed in the Physics Test Facility. Also, further microwave interferometry measurements were performed, and some interesting measurements on the plasma instabilities were performed with small coils. (auth)

13138 (ORNL-3564(p.44-62)) PLASMA PHYSICS. (Oak Ridge National Lab., Tenn.).

Several combinations of magnetic cusps and mirrors were evaluated for their ability to contain cold plasma. Plasma noise and density were measured. The plasma was considered stable if its loss rate was not greater than that permitted by ion-ion multiple scattering. Cusps were found to be stable and their loss rates could be reduced by bending the cusp annulus with added axially parallel uniform field. A plasma containing electrons at 25 to 100 kev temperature was found to be stable in a simple magnetic mirror configuration. The discrepancy previously observed in measurements of plasma density using a resonant cavity as compared with measurements using a plasma sweeper is now apparently understood. Further experiments concern-

ing the time-of-flight technique of measuring ionic-sound-wave velocity support previous work and reveal interesting new phenomena, such as reflections. Extensive use was made of a modified Snooperscope (a fast stroboscopic, image-converting device) to study moving striations of light in the inert gases in cylindrical discharge tubes. Present evidence suggests that the striations are produced by ion waves propagating down the tube. A simple addition was made to the original converter circuit that allows correction to be made for the collection of positive ions (automatic converter circuit). (auth)

13139 (ORNL-3564(p.63-71)) VACUUM ARC RESEARCH. (Oak Ridge National Lab., Tenn.).

The magnetically constrained, high-density deuterium arc plasma was shown previously to be highly ionized and relatively quiescent. It appeared to be a good plasma for the study of plasma diffusion across a magnetic field in the regime where only charged-particle collisions were important. However, Langmuir probe measurements of the region outside the main arc plasma indicate that the particle transport across the magnetic field is dominated by flutes generated by the main arc plasma. The flutes, with a cross-sectional area of about 0.2 cm^2, apparently extend the full length of the arc through a 2:1 magnetic mirror. The flutes have both radial and azimuthal velocities of 1 to 5×10^5 cm/sec across the magnetic field that are dependent on the magnetic field strength, the arc current, and the radius at which the measurement is made. The heating and energy mixing of ionic species of energetic carbon arcs are discussed qualitatively in terms of ion-ion charge-exchange reactions and other contributing mechanisms. Improvements in the electrode configurations of the lithium arc are described. (auth)

13140 (ORNL-3564(p.73-9)) PRODUCTION, ACCELERATION, AND INJECTION OF IONIC AND ATOMIC BEAMS. (Oak Ridge National Lab., Tenn.).

The 600-kv high-intensity beam test stand delivered up to 95 mamp of H_3^+ ion current through a 4-cm aperture located 350 cm from the ion source. The previously observed current limitation of 60 mamp proved to be a decreased relative production of H_3^+ ions in the duoplasmatron ion source. This limitation was improved by small changes in the geometry of the source. The DCX-2 injector system, which has several operating requirements not included in the 600-kv test stand, may be limited to an injected H_3^+ current of only 40 mamp. Since the calorimetric beam accountability is only 80% of the drain on the supply, it is not certain that the injected current is really this low. Modifications in the epoxy skirts continued to improve the voltage holding capacity of the 600-kv accelerating column on the atmospheric side. A hollow-cathode arc ion source was satisfactorily operated at 30 kv in an assembly that will permit comparison of neutral beam production from either a gas cell or another hollow-cathode discharge. A total hydrogen ion beam of 35 mamp was attained with a divergence angle of 10°. (auth)

13141 (ORNL-3564(p.80-99)) PLASMA THEORY AND COMPUTATION. (Oak Ridge National Lab., Tenn.).

The correspondence between hot-electron and hot-ion plasmas generated in experiments and the predictions of stability theory are summarized. Stability of hot-electron plasmas generated by cyclotron heating is attributed to conductivity to end walls by cold plasma, and possibly to other stabilizing effects of the low-energy component of the plasma continually replenished by ionization of the large neutral gas background found to be necessary for stable operation. In the DCX experiments, enhanced energy and spatial diffusion (in DCX-1) are attributed to charge-bunching, for example, by ion-electron microinstabilities as suggested by Harris. The development of Harris's theory is reviewed. It is argued that flutes and other macroinstabilities are ruled out by finite orbit effects. Also, the values of density and magnetic field such that a two-temperature ion distribution is stable against the Harris instability are mapped for various ratios of temperature parallel and perpendicular to the magnetic field. A previously developed technique for obtaining exact upper bounds on growth rates of instabilities was applied to configurations confined in mirror machines. The fastest growth is that of Harris's electrostatic streaming instabilities. The same technique was used in obtaining bounds on growth rates, which are then employed in setting a lower bound on the diffusion time across a magnetic field. It was found that, for practical purposes, confinement of quite dense plasmas, if they are several ion gyro-radii across, is not limited by cross-field diffusion, even if microinstabilities are present. The implication is that closed containers designed for macrostability, such as the toroidal multipole, should be stable in practice. Effects on hot-electron plasmas of energy loss by radiation following collisional excitation of impurities were calculated. Qualitative agreement is obtained with experiments in which xenon was introduced into the PTF hot-electron plasma. A new approach to stabilization of bounded plasmas by electron streams was undertaken—that of considering the system as a finite, bounded plasma. In electron-electron and electron-ion collisions, the presence of a strong magnetic field theoretically was shown to impede the transfer of energy from the direction parallel to the field to the perpendicular directions. Preliminary phenomenological fits to data for energy diffusion in DCX-2 by microinstabilities give diffusion times a factor 10^7 to 10^8 shorter than Coulomb diffusion, but $\sim 10^4$ longer than the microinstability growth time. (auth)

13142 (RADC-TDR-63-135) STUDY OF THE GENERATION OF COHERENT ELECTROMAGNETIC RADIATION BY A PULSATING PLASMA. Final Report. R. E. Skinner (Radio Corp. of American, Camden, N. J.). Feb. 1963. Contract AF30(602)-2510. 78p. (AD-404539)

Coherent radiation from a plasma stimulated by a modulated electron beam at frequencies above the hybrid frequency was observed, with electronic gains of more than 20 db. The measurements were made in the 3.95- to 5.85-Bc region. The cyclotron frequency was 2.90 Bc and the hybrid frequency was less than 3.18 Bc. The experiment was performed with a cesium plasma. The experiments, their results, and the experimental facilities are described. (auth)

13143 (SSD-TDR-63-338) MINIMUM LENGTH MHD ACCELERATOR WITH CONSTANT ENTHALPY AND MAGNETIC FIELD. Harold Mirels, Richard R. Gold, and James F. Mullen (Aerospace Corp., El Segundo, Calif.). Nov. 29, 1963. Contract AF04(695)-269. 14p. (AD-427665)

A closed form solution is obtained for the minimum length of a crossed field MHD accelerator with specified entrance and exit conditions. It is assumed that the enthalpy, magnetic field, and electrical conductivity are constant. The solution is valid when the joule heating per unit volume is small compared with the net local electrical power input. (auth)

13144 (TID-20137) [PLASMA PHYSICS]. Quarterly Progress Report, November 1, 1963 through January 31, 1964. (New York Univ., New York). Feb. 10, 1964. Contract AT(30-1)-2397. 6p.

Tests on Cs fed into the plasma cylinder revealed inadequate control over the Cs flow, apparently due to alloying of the Cs with the Cu of the feed system. Cs flow through tubes of various materials was, therefore, investigated. Cu and stainless steel tubes with Ta lining appear to provide the control desired. Also, the shape and intensity of beams from the fast neutral source were measured for varying parameters. (D.C.W.)

13145 LONG WAVELENGTH OSCILLATIONS OF A QUANTUM PLASMA IN A UNIFORM MAGNETIC FIELD. N. David Mermin and Eric Canel (Univ. of Birmingham, Eng.). Ann. Phys. (N. Y.), 26: 247-73(Feb. 5, 1964).

The density waves that an electron gas can sustain in a uniform magnetic field are discussed in the limit of long wavelengths. The electrons are taken to interact via Coulomb forces, which are treated in the random phase approximation. Two excitations exhaust the long wavelength sum rule. They arise from a competition between the Lorentz force due to the magnetic field and the tendency to execute longitudinal plasma oscillations; the resulting motion is one in which, when semiclassical conditions hold, the local Fermi sphere moves along an elliptical orbit in velocity space. The wavelength dependence of the two resonant frequencies is calculated to order k^2 for general angles between the direction of propagation and the magnetic field. It is observed that in general a magnetic field increases the amount of Landau damping. There are additional resonances very close to twice and higher integral multiples of the Larmor frequency. These are very weakly excited by a long wavelength longitudinal disturbance, and undergo heavy Landau damping unless the direction of propagation is very nearly perpendicular to the magnetic field or the temperature is very close to zero. Their wavelength dependence is discussed in these two cases. When propagation is perpendicular to the magnetic field this dependence is very much like that of the classical problem; however, at zero temperature and nonperpendicular directions of propagation the ω versus k dependence is quite different, and the waves are very similar to zero sound. (auth)

13146 THE SPATIAL DISTRIBUTION OF ELECTRON TEMPERATURE IN A WEAKLY IONIZED LOW-PRESSURE PLASMA IN HOMOGENOUS MAGNETIC FIELD. L. Schott (Universität, Kiel). Ann. Physik (7), 12: 121-32(Nov. 1963). (In German)

Probe measurements in a cylindrical diffusion chamber gave the spatial distribution of electron temperature. An increase in electron temperature toward the vessel walls at small magnetic field strengths was observed, which can be explained qualitatively with an introduced model. At high magnetic fields a decrease in electron temperature towards the walls was found, which was due to a transversal cooling mechanism of the electron gas by collision of two bodies. Relations between the average electron temperature and the magnetic field strength were derived from the theory of two-dimensional diffusion and compared with measured results. (tr-auth)

13147 A THEORY CONCERNING THE STABILITY OF THE NONHOMOGENEOUS PLASMA AND THE PROBLEM OF ANOMALOUS DIFFUSION. A. A. Galeev, S. S. Moiseev, and R. Z. Sagdeev. At. Energ. (USSR), 15: 451-67(Dec. 1963). (In Russian)

The stability of the low-pressure plasma, $p \ll H^2/8\pi$, confined by a magnetic field was examined with respect to the drift wave related to its nonhomogeneous character. A 2-liquid hydrodynamic equation system of the electrons and ions was used for determining the stability of a nonhomogeneous, low-pressure plasma possessing a finite conductivity. It was found that dissipative effects, in particular, finite electric resistivity, play an important role. The nonlinear effect of the plasma instability and of the anomalous diffusion were considered in a semiquantitative manner, using a strict, linear theory of the stability, defining the critical value of the magnetic field. The results obtained by calculation were compared with experimentally obtained data. In addition, the drift wave in a high-temperature plasma was examined by analyzing the linear theory of stability on the basis of critical equations, without considering collisions. A quasilinear method was used for calculating the effect of the drift wave on the diffusion of particles in an unstable plasma. (TTT)

13148 EFFECTS OF COULOMB COLLISIONS ON LONGITUDINAL PLASMA OSCILLATIONS. T. W. Johnston and I. P. Shkarofsky (RCA Victor Research Labs., Montreal). Can. J. Phys., 42: 193-9(Jan. 1964).

This theoretical analysis shows that the Fokker–Planck equation can be applied to obtain identical wavelength-dependent (k^2) damping as previously derived from the much more complicated Liouville equation approach. It is also noted that electron ($\omega \sim \omega_p$) and ion ($\omega \sim \Omega_p$) oscillations are only slightly damped by Coulomb collisions. The k^2 dependent damping is difficult to observe for electron oscillations but perhaps not for ion oscillations (where it is the only Coulomb damping) if Landau damping effects do not obscure the observation and if the electron temperature is not too high compared with the ion temperature. The electron and ion oscillations are effectively free (the ratio of specific heats γ multiplying the temperature is effectively 3). The low-frequency sound oscillations ($\omega \ll \Omega_p$) are isothermal for electrons ($\gamma = 1$) and can be adiabatic ($\gamma = 5/3$) or free ($\gamma = 3$) for ions as the ion–ion collision frequency is much more or less than ω. (auth)

13149 THE COLLISION TERM IN THE BOLTZMANN EQUATION OF A GAS. APPLICATION TO THE INCOHERENT SCATTERING OF AN ELECTROMAGNETIC WAVE BY A PLASMA. Philippe Waldteufel (Centre National d'Etudes des Telecommunications, Departement C.D.S., Issy-les-Moulineaux, France). Compt. Rend., 257: 3835-7(Dec. 16, 1963). (In French)

A proposal is made to represent the effect of collisions between neutral particles and charged particles in a plasma by the introduction of a phenomenological term into the evolution equation of a gas. This term can explain correctly the transfer of the quantity of movement. The result obtained is utilized to calculate the spectrum of incoherent scattering by a plasma in which the collisions can not be neglected (low ionosphere and laboratory plasmas). (tr-auth)

13150 ELECTRON DISTRIBUTION FUNCTION OF AN ANISOTROPIC AND INHOMOGENEOUS LORENTZIAN PLASMA IN THE PRESENCE OF SEVERAL MODULATED ELECTRIC FIELDS. Diptendu Basu, Raymond Jancel, and Theo Kahan. Compt. Rend., 258: 837-40(Jan. 20, 1964). (In French)

The distribution function of a plasma under the effect of several superposed, modulated electric fields is calculated. The result is used to calculate the electron current in a plasma under the effect of two superposed fields, only one of which is modulated. (D.C.W.)

13151 THE FREQUENCY SHIFT OF LIGHT SCATTERED BY A RELATIVISTIC PLASMA. O. Pogutse (Kurchatov Inst. of Atomic Energy, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 153: 578-80(Nov. 21, 1963). (In Russian)

The independent-particle equations can be used to describe the scattering of light (high-frequency electromagnetic waves) by an isotropic Maxwellian plasma if the frequency of the incoming light $\Omega \gg \omega_0/\beta_T$, where ω_0 is the electron plasma frequency and $\beta_T^2 = 2T/mc^2$. Collective effects are only important for Ω in the neighborhood of the plasma frequency. For a weakly relativistic plasma ($\beta_T \ll 1$), only the terms linear in β_T are retained in the equations; the frequency of the scattered light $\omega = \Omega(1 + 2\beta_T^2(1 - \cos\theta))$, where θ is the angle between k and j, the propagation vectors of the scattered and incoming light. For a highly relativistic plasma ($\beta_T = 1$), the frequency shift is given by the Doppler shift: $\omega - k \cdot v = \Omega - j \cdot v$, where v is the particle velocity. The scattering cross sections are also given. For a highly relativistic plasma, the cross section for right-angle scattering has a maximum for $\omega = 2\beta_T^2\Omega$. The total cross section is of the order of $(e^2/mc^2)^2 (T/mc^2)_2$. (TTT)

13152 THE HYDROMAGNETIC STABILITY OF A ROTATING PLASMA. L. S. Solov'ev. Dokl. Akad. Nauk SSSR, 153: 1048-51(Dec. 11, 1963). (In Russian)

The conditions of hydromagnetic stability were derived for an adiabatic cylindrical plasma with arbitrary density, velocities, temperature, and internal magnetic field. The hydromagnetic equations were used to describe the propagation of a linear wave of the form exp i (kz – mϕ + ωt), and to find the conditions under which the frequency ω retains an imaginary part. Axial, azimuthal, and helical perturbations were considered for plasmas bounded by an ideally conducting cylindrical sheath (pinch), or by an external magnetic field. It is shown that the pinch is unstable with respect to helical perturbations (when the plasma rotates as a whole). (TTT)

13153 ION WAVE RESONANCE AND PLASMA INSTABILITY IN A CESIUM DISCHARGE. John A. Decker, Jr. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). J. Appl. Phys., 35: 497-501(Mar. 1964).

Coherent audiofrequency electrostatic oscillations were directly observed in the probe noise of a cesium glow discharge at pressures from 10^{-2} to 10^{-5} torr and magnetic fields up to 4500 G; observed oscillation frequencies corresponded to frequencies for classical ion waves, as proposed by Tonks and Langmuir, in resonance with the discharge tube length. The discharge was extinguished coincidently with a rapid growth of wave amplitude if the current or magnetic field was increased above critical values. This was tentatively identified as a helical plasma instability of the type first suggested by Kadomtsev and Nedospasov, although the observed correlation between instability onset and wave growth has not yet been satisfactorily explained. (auth)

13154 WIDENING OF THE INFRARED LINES OF ARGON IN AN ARC JET. E. Fabre, J. Séguier, and L. Herman (Laboratoire des Recherches Physiques, Sorbonne, Paris). J. Phys., 24: 737-40(Oct. 1963). (In French)

The profiles of the infrared ArI lines emitted by a plasma jet were observed and compared with the line profile theory given by Lindholm; for the lines with upper f levels, the linear Stark effect had to be taken into account. (auth)

13155 UNIFIED THEORY OF RELAXATIONS IN PLASMAS. III. QUANTUM EFFECTS. Taro Kihara (Tokyo Univ.). J. Phys. Soc. Japan, 19: 108-16(Jan. 1964).

The connection formula which unifies the impact and wave theories, is generalized so as to make quantum mechanical calculation possible. A relaxation rate X is given in the form $X = X_\kappa + X_{wave} - X_{wave,\kappa}$. Here X_{wave} is the quantity calculated in the wave theory; $X_{wave,\kappa}$ is the quantity to which X_{wave} is reduced when the dielectric permeability is replaced by $1 + \kappa^2/k^2$, which depends on the wave number k only; X_κ is the quantity calculated in the collision theory with use of the screened Coulomb potential of the form $e^{-\kappa r}/r$; and κ^{-1} is any length considerably longer than the close impact radius. The final result is independent of κ. Applications are given. (auth)

13156 LONG WAVES ASSOCIATED WITH DISTURBANCES PRODUCED IN PLASMAS. H. Bremmer (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). J. Res. Natl. Bur. Std., 68D: 47-58(Jan. 1964).

The disturbances generated in a homogeneous plasma by moving charges are analyzed. The decomposition of field disturbances into a low-frequency spectrum is considered. Idealized ionospheric disturbances are discussed. (R.E.U.)

13157 THE RELATIONSHIP BETWEEN THE EXCITATION TEMPERATURE AND THE GAS TEMPERATURE IN THE POSITIVE COLUMN OF AN ARC DISCHARGE. D. B. Gurevich and I. V. Podmoshenskii. Opt. Spectry. (USSR) (English Transl.), 15: 319-22(Nov. 1963).

A relaxation method is suggested for measuring the difference between electron and gas temperatures, based on their different rates of decrease. Temperature differences were measured by this method in arcs in air, argon, and mercury under various conditions. Some estimations were made which make it possible to discuss the mechanism of the exchange of energy between electrons and heavy particles in arcs. (auth)

13158 RUNAWAY ELECTRONS IN AN IDEAL LORENTZ PLASMA. Martin D. Kruskal and Ira B. Bernstein (Princeton Univ., N. J.). Phys. Fluids, 7: 407-18 (Mar. 1964).

The phenomenon of electron runaway under a constant electric field is treated in the simplified model of a Lorentz gas, in which the electrons experience Coulomb collisions with infinitely massive ions only. This model permits a rigorous systematic analysis of the problem, devoid of arbitrary elements, in the limit of weak electric field. The analysis leads to a decomposition of velocity space into three regions. In the first of these, the low velocity domain, the electron distribution function is dominated by collisions and hence almost isotropic; it obeys a diffusion equation driven by the applied field. The second region, one of intermediate velocity, is characterized by quasi-steady flow in velocity space, for which the low velocity region provides the source. Lastly there is a high velocity region, fed by the intermediate region, in which the electrons run away almost freely under the action of the electric field, with only an exceedingly weak diffusion due to collisions. The problem is solved explicitly in the first and third regions and reduced to solving a single universal partial differential equation in the second region. The runaway rate, number of runaway electrons, and electric current density (average electron velocity) are obtained explicitly. (auth)

13159 THERMAL RELAXATION IN A ONE-SPECIES, ONE-DIMENSIONAL PLASMA. John M. Dawson (Princeton Univ., N. J.). Phys. Fluids, 7: 419-25(Mar. 1964).

Kinetic theories for a one-species, one-dimensional plasma that take into account only two-particle correlations predict all stable distributions are time independent and there is no relaxation to a Maxwellian. This is investigated by numerical experiments on a one-dimensional plasma model where the initial distribution was square. The theory is verified in that it is found that the relaxation times goes

like n_D^2 and appears to be caused by three-particle correlations. In addition to the slow relaxation an initial transient was found that lasted for a time of the order of $1/\omega_p$ and is accounted for by an elementary theory. (auth)

13160 THERMOELECTRIC EFFECTS IN A JOULE-HEATED PLASMA. Laurence S. Hall (Univ. of California, Livermore). Phys. Fluids, 7: 425-7(Mar. 1964). (UCRL-7470)

The temperature and potential distributions in a fully ionized, Joule-heated plasma were computed for a one-dimensional system in which the thermoelectric terms were taken into account, and a comparison is made with the case in which the cross terms are neglected. It is found that the thermoelectric terms cause the temperature distribution to be significantly skewed. Moreover, if T_0 is the maximum temperature, it is found that these terms cause the potential to drop sharply near the anode, in the sense opposing the current flow, by from 15 to 35% of kT_0/e. (auth)

13161 NONTHERMAL IMPURITY RADIATION FROM A SPHERICAL PLASMA. [PART] II. S. Cuperman, F. Engelmann, and J. Oxenius (Euratom-CEA, Fontenay-aux-Roses, France). Phys. Fluids, 7: 428-38(Mar. 1964).

The steady-state radiation loss of a homogeneous and isothermal spherical plasma due to an optically thick spectral line is calculated under the assumption that all other transitions of the considered atoms rem[illegible] optically thin. The line profile is approximated by a rectangular profile and by a Doppler profile, respectively. The energy losses found can be described in almost all cases of practical interest by a volume radiation formula and are in general much smaller than the losses corresponding to thermal radiation. In the case of an optically thick plasma emitting radiation far from thermal equilibrium the spectral distribution of the intensity is double humped simulating a self absorption effect of a cold outer layer. The consistency of the assumption of a spatially constant absorption coefficient on which the calculations were based is checked. The Eddington approximation is shown to be in good agreement with the exact solution of the problem. The numerical results are compared with those obtained from algebraic formulas valid in some limiting cases. (auth)

13162 SCATTERING OF ELECTROMAGNETIC WAVES BY A PLASMA CYLINDER. J. A. Fejer (General Motors Corp., Santa Barbara, Calif.). Phys. Fluids, 7: 439-45 (Mar. 1964).

The scattering of an electromagnetic wave by a plasma cylinder is investigated. The problem of the homogeneous cylinder is solved analytically. Numerical solutions are obtained for two selected examples in which the plasma is cylindrically symmetrical but inhomogeneous. In the calculations, the thermal motion of the electrons is taken into account approximately by a scalar pressure term. The results of the calculations show that resonant scattering takes place at several frequencies. At the lowest resonant frequency the thermal motion of the electrons plays little part, and the plasma behaves essentially as a dielectric. Thermal motion plays a prominent part in the resonances that occur at the higher frequencies and that are caused by standing plasma waves (electron acoustic waves). These higher resonant frequencies are rather closely spaced (starting from just above the plasma frequency), if the plasma cylinder is homogeneous and its diameter is much greater than the Debye length. The separations between the resonant frequencies increase, however, if the electron density is taken to be substantially greater on the axis of the cylinder than at the boundary. The results of the computations for such an inhomogeneous cylinder appear to be in qualitative agreement with data obtained from experiments on the resonant scattering of microwaves by a gas discharge column. (auth)

13163 ANALYSIS OF ELECTROMAGNETIC WAVE PROPAGATION THROUGH MAGNETOACTIVE PLASMAS. Richard R. Gold (Aerospace Corp., El Segundo, Calif.). Phys. Fluids, 7: 446-54(Mar. 1964).

A detailed analysis of electromagnetic wave propagation through a stratified magnetoactive plasma layer is presented. Exact solutions for the reflection and transmission coefficients are obtained for two general electron density distributions; kinked-trapezoid and exponential-homogeneous-exponential. Oblique incidence is considered with no magnetic field; a constant magnetic field applied normal to the layer is included for the case of normal incidence (ion cyclotron resonances are not considered). Numerical results are presented to illustrate the effect of the inhomogeneous plasma model on transmission. The asymptotic expansion of the solution for the kinked-trapezoid profile provides a simplified expression for calculation purposes when L/λ_0 (ratio of slab width to free space wavelength) is larger than one. An infinite series solution is obtained in the final section based on an integral equation formulation of the problem including arbitrary variations in the properties of the stratified plasma (collision frequency as well as electron density). Relatively simple algebraic expressions for the reflection and transmission coefficients are derived when L/λ_0 is small. Propagation across thin plasma slabs can be analyzed readily on this basis. (auth)

13164 NONLINEAR WAVE MOTION IN A LINEAR PINCH. Chong-Wei Chu (Northrop Norair, Hawthorne, Calif.). Phys. Fluids, 7: 455-62(Mar. 1964).

The motion of a linear pinch due to finite axisymmetric disturbances is studied. The plasma is considered as a single, inviscid, perfectly conducting, compressible fluid, and the usual magnetohydrodynamic assumptions are made. Theory of characteristics is applied to study simple waves. A compression simple wave is found to steepen with time and is expected to develop into a shock with area change. It is found that the increase of entropy across such a shock is greater than that across an ordinary normal shock with the same pressure ratio. With respect to a single finite axisymmetric concave or convex disturbance with small area gradient in the axial direction, the pinch is stable in the sense that it will nowhere touch the coaxial wall and its physical quantities will remain finite. (auth)

13165 INFLUENCE OF ION LOSS ON DIFFUSION OF CESIUM PLASMA IN THE Q MACHINE. S. V. Goeler (Universität, Marburg, Ger.). Phys. Fluids, 7: 463-9 (Mar. 1964).

It is shown that neutralization of the ions at the hot end plates dominates over the process of volume recombination in the Q machine. A wall recombination coefficient is defined and calculated for comparison with the experimental data. Further, the maximum plasma density that can be obtained with the Q machine is discussed. (auth)

13166 LONG-WAVELENGTH PLASMA OSCILLATIONS. Harold Weitzner (New York Univ., New York). Phys. Fluids, 7: 476-7(Mar. 1964).

It is shown that in an appropriate limit exact plane wave solutions of the Vlasov equation exhibit plasma oscillations and no observable Landau damping. Aside from this limiting case, plasma oscillations are not expected to be observable. The treatment presented applies to any stable plasma. (C.E.S.)

13167 COMMENTS ON "NONLINEAR LANDAU DAMPING OF OSCILLATIONS IN A BOUNDED PLASMA." David Montgomery (Univ. of Maryland, College Park). Phys. Fluids, 7: 477-8(Mar. 1964).

A perturbation expansion of the nonlinear Vlasov equation presented previously (NSA 17: 33169) is discussed. It is shown that the predictions of this perturbation expansion are confirmed in a numerical integration of the nonlinear Vlasov equation. (C.E.S.)

13168 PLASMAS IN SOLIDS. Raymond Bowers (Cornell Univ., Ithaca, N. Y.). Sci. Am., 209: 46-53(Nov. 1963).

The nature of plasmas and their occurrence in the universe are discussed. The factors that influence the propagation of a wave in a plasma that contains a large magnetic field are discussed. Waves with unique properties, known as whistler waves, frequently propagated in the rarefied plasma of the earth's ionosphere, are described. Experiments are described in which the same whistler waves may be excited in the electron gas of a metal and precise comparisons made between theory and experiment. Certain metals were found to be ideal subjects for this kind of study. Sodium was used, with its temperature lowered to that of liquid helium. The second type of magnetoplasma wave discussed, with a character different from that of the whistler wave, was the dominant wave mode in a plasma that has equal numbers of positive and negative charges, both of which are highly mobile. Properties of such, so-called Alfven waves are described, and their production in metals discussed. The concept of using solids to study plasma behavior is considered, and it was concluded that experiments in solids will make important contributions to understanding the most ubiquitous stuff in the universe: the gas plasma. (TCO)

13169 EXCITATION, PROPAGATION, AND DAMPING OF ION ACOUSTIC WAVES IN HIGHLY-IONIZED PLASMAS. Alfred Yiu-fai Wong. Thesis, Princeton, N. J., Princeton Univ., 1963. 33p.

In highly ionized Cs and K plasmas (5×10^{10} cm^{-3} < n < 5×10^{11} cm^{-3}), ion acoustic waves have been excited by the modulation of the potential of a tungsten grid immersed in the plasma. The frequencies of modulation are between 10 and 100 kc. The waves are detected by a similar grid, which can be moved along the plasma column. Phase velocities of 1.3×10^5 cm/sec were found for Cs and 2.5×10^5 cm/sec for K with no measurable dispersion. These phase velocities are 50% in excess of those predicted for a collisionless plasma with equal ion and electron temperatures $v_{ph} = (5.8kT/m_i)^{1/2}$, T ≅ 2300°K. The wave-damping distance is observed to be independent of density and is a constant fraction of a wavelength, as predicted for Landau damping. (Dissertation Abstr.)

13170 ELECTRON TEMPERATURE IN THE RAPID EXPANSION OF A PLASMA FLOW. I. R. McNab and B. C. Lindley (C. A. Parsons & Co., Ltd., [Newcastle upon Tyne, Eng.]). p.27-46 of "Advances in Magnetohydrodynamics." New York, The Macmillan Co., 1963.

Under conditions of low pressure and high acceleration (rapid expansion) of a flowing plasma, such as could conceivably occur in forms of magnetoplasmadynamic electrical power generator, it is postulated that the electron-temperature may be considerably higher than the gas temperature. This situation could have important effects on ionization, electric conductivity, and on ion-electron recombination processes. An attempt is made to define regimes in which the elevated electron temperature effect could occur, and to obtain quantitative information for pure cesium and helium–cesium plasmas. (auth)

13171 COMPARISONS OF EXPERIMENTAL AND THEORETICAL ARC COLUMN CHARACTERISTICS. H. E. Weber and T. K. Pugmire (General Electric Co., Philadelphia). 37p. (CONF-24-21)

From 4th Symposium on Engineering Aspects of Magnetohydrodynamics, Berkeley, Calif., Apr. 1963.

The integration of the energy equation for air flow through an arc column is conducted for the inlet vortex chamber of a constricted arc. The resulting relations of temperature, flow rate, current, voltage gradient, and arc geometry are compared with the measured quantities. The temperatures were obtained spectrographically while the other parameters were measured in more routine fashion. The correlation between theory and experiment is fair to good but requires further refinement. (auth)

13172 DEVICE FOR THERMONUCLEAR GENERATION OF POWER. Willard H. Bennett. U. S. Patent 3,120,475. Feb. 4, 1964. Filed Oct. 10, 1957.

A thermonuclear reactor is described in which electrodes are provided at the ends of the reaction chamber, the potential applied to the electrodes acting to confine particles in the chamber to produce a sustained thermonuclear reaction. An a-c discharge between the electrodes is used to ionize the chamber gas. (R.E.U.)

13173 PLASMA HEATING AND CONFINING SYSTEM. William R. Baker (to U. S. Atomic Energy Commission). U. S. Patent 3,125,492. Mar. 17, 1964.

An apparatus for confining and heating plasma is described that utilizes a magnetic containment field having an entrance zone that extends along a planar region, rather than being confined to a single linear axis, together with an injection apparatus in which a column of plasma is propelled at right angles to its length into the containment field. Thus, a long plasma column may be laterally accelerated into the containment region from two opposite sides thereof producing a high concentration of plasma therein and a high degree of heating. In a further application of the concept, the plasma gun completely encircles the containment field, and an annular plasma body is accelerated radially inward to concentrate at the center of the field. (AEC)

Shielding

Refer also to abstract 12720.

13174 (CEAL-1007) EFFECTIVENESS OF ILMENITE-LOADED CONCRETE IN ATTENUATING NEUTRON RADIATION PRODUCED BY A 5-Bev PHOTON BEAM. Samuel Kao and Gustav-Adolf Voss (Cambridge Electron Accelerator, Mass.). Dec. 20, 1963. Contract [AT(30-1)-2076]. 9p.

The neutron radiation was produced by directing a 5-Bev bremsstrahlung beam at a heavy copper quantameter serving as target. The transverse (90°) neutron flux was attenuated by a variable-thickness wall of ilmenite-loaded concrete having a density of 4.0 g/cm^3; and the biological dose, in rems, behind the wall was determined with the aid of a Texas Nuclear Corporation Model 9120 neutron dosimeter. The half-value thickness of the ilmenite-loaded concrete was found to be 3.2 in. when the wall thickness was 1 to 2 ft and 6.4 in. when the thickness was 2 to 3 ft. (auth)

13175 (ESD-TDR-63-231) TECHNIQUES FOR NUCLEAR SHIELDING CALCULATIONS. K. F. Hansen

(Mitre Corp., Bedford, Mass.). May 1963. Contract AF19(628)-2390. 29p. (AD-407300)

Selected methods for nuclear shielding calculations are reviewed. The techniques considered are numerical integration of the Boltzmann equation, moments method, Monte Carlo, method of successive scatterings, and removal cross section method. The merits of each particular method are outlined along with a new simplified calculation procedure. (auth)

13176 (NAA-SR-Memo-9327) MORTIMER—A MODIFICATION OF THE RATRAP CODE WHICH INCLUDES THE TWO COMPONENT METHOD OF SHIELD ANALYSIS. W. B. Green (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 16, 1963. Contract [AT(11-1)-Gen-8]. 74p.

The program MORTIMER, a revision of RATRAP designed to include the effects of scattered and uncollided particles in the calculation of dose rates at points outside the shield system, is described. The scattered and uncollided parts of the dose can be calculated, as well as the removal theory particle dose rate and the dose rate from a leakage surface or a combination of the two. A sample case and the program listing are included. (D.C.W.)

13177 (NARF-62-16T) ENERGY AND ANGULAR DISTRIBUTION EXPERIMENT. VOLUME II. ANGULAR DISTRIBUTION OF FAST-NEUTRON AND GAMMA-RAY NUMBER-ENERGY FLUX FROM SLABS. G. T. Western (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). Sept. 30, 1963. Contract AT33 (657)-7201. 47p. (FZK-9-183-2)

A narrow beam of neutrons and gammas from the Aerospace Shield Test Reactor was directed against 3% borated polyethylene slabs and lead slabs of various thicknesses. The results of measurements of the angular distributions of fast neutron and gamma dose rates and fast neutron and gamma number-energy flux are presented. The experimental arrangement and procedures are also described. (D.C.W.)

13178 (ORNL-3549) SPACE VEHICLE SHIELDING STUDIES. PART III. THE ATTENUATION OF A PARTICULAR SOLAR FLARE BY AN ALUMINUM SHIELD. R. G. Alsmiller, Jr. and J. E. Murphy (Oak Ridge National Lab., Tenn.). Feb. 20, 1964. Contract W-7405-eng-26. 7p.

Using the straight-ahead approximation, nucleon-meson cascade calculations were carried out for a particular solar-flare proton spectrum incident on a shield. The shielding material has approximately the properties of aluminum. Both spherical-shell and slab geometries are considered. (auth)

13179 (ORNL-3570) A SOLUTION TO THE NUCLEON-MESON CASCADE EQUATIONS UNDER VERY SPECIAL CONDITIONS. R. G. Alsmiller, Jr. (Oak Ridge National Lab., Tenn.). Mar. 1964. Contract W-7405-eng-26. 31p.

The equations that describe a one-dimensional nucleon-meson cascade are solved under the assumptions that the secondary-particle production kernels are taken to be of the special form $F_{ij}(E',E) = \alpha_i\gamma_j\, e^{\nu(E'-E)}$ for all i,j and α_i,γ_j, ν = const., pion decay is neglected, pion and nucleon nonelastic cross sections are taken to be constant, and the stopping powers of all charged particles are equal to the same nonzero constant. (auth)

13180 (RM-3575-PR) SINGULAR SOLUTIONS OF AN INTEGRO-DIFFERENTIAL EQUATION IN RADIATIVE TRANSFER. T. W. Mullikin (RAND Corp., Santa Monica, Calif.). Apr. 1963. Contract AF49(638)-700. 19p. (AD-402496)

In the theory of radiative transfer in a homogeneous isotropic slab of thickness, T, the scattering (reflection) function can be determined by a nonlinear integro-differential equation and initial conditions. A set of initial conditions for which the solutions to the nonlinear integro-differential equation are infinite for finite values of the parameter, T, are presented. Some of these singular solutions first come close to the desired solution and then diverge to infinity. The nearness of approach of these singular solutions is proportional to a quantity which measures the nearness of local scattering to the conservative case. The conservative case is again found by a continuous passage from nonconservative to conservative scattering. (auth)

13181 SOLUTIONS OF THE GAMMA-RAY TRANSPORT EQUATION USING TSCHEBYSCHEFF POLYNOMIAL EXPANSIONS AND THE MOMENTS METHOD. Joe Jackson Stewart. Thesis, Raleigh, N. C., Univ. of North Carolina, 1963, 145p.

The Tschebyscheff polynomial expansion technique is used in conjunction with the method of moments to obtain solutions of the γ-ray transport equation. The integral equations for the moments are derived, and reconstructions are performed using polynomial expansion methods. Plane and point isotropic, monoenergetic sources are considered. Numerical results are presented for a Cs^{137} source in water and concrete and compared with the conventional Legendre approach. Comparisons are made on the basis of energy spectra, dose buildup factors, and dose angular distributions. Comparisons of plane geometry indicate that the Tschebyscheff method yields approximately the same results as the conventional Legendre approach; however, the computer time required by the Tschebyscheff calculations is greater. Included in the analytical development are addition formulas for Tschebyscheff polynomials. (Dissertation Abstr.)

13182 IMPROVEMENTS IN OR RELATING TO SHIELDING FOR PACKAGE IRRADIATION PLANT. Sidney Jefferson (to United Kingdom Atomic Energy Authority). British Patent 948,973. Feb. 5, 1964. Filed Oct. 31, 1961.

Biological shielding of gamma sources used in package irradiation is described with minimization of radiation scatter in labyrinth sections in the shield. A turntable is provided at the junction of two passages in the labyrinth. Radiation shielding is associated with the turntable so that when packages are transported from the outside of the source located at the end of a passage, the turntable must change the package route by 90°. The shielding then eliminates the possibility of radiation scatter from the passage walls reaching the outside. (R.E.U.)

13183 SCATTERING RADIATION SHIELD. Kalman M. Held and Carl N. Klahr. U. S. Patent 3,121,794. Feb. 18, 1964. Filed Oct. 12, 1959.

Radiation shielding particularly applicable to crew compartments or instrument packages in manned or unmanned reactor-powered space vehicles is described. Scattering, rather than absorption, is used as the predominant means of eliminating radiation. (R.E.U.)

13184 RARE EARTH SHIELD. Nathan Klein (to Secretary of the Army). U. S. Patent 3,123,576. Mar. 3, 1964. Filed Oct. 5, 1962.

A paint composition is described that is capable of absorbing thermal neutrons. An oxide of Gd, Sm, or Eu is included in finely divided form in the drying oil. (R.E.U.)

REACTOR TECHNOLOGY

General

Refer also to abstract 12368.

13185 (BAW-1288) STUDY AND RECOMMENDATIONS RELATIVE TO LOSS OF FLUID TEST FACILITY. HIGH VERSUS LOW PRESSURE DESIGN. (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). Nov. 1963. Contract AT(10-1)-1187. 82p.

A study is presented comparing a 1200 psig to a 2500 psig design pressure LOFT experimental facility investigating the loss of fluid accident and the expected differences in the results of such experiments. The primary system mass dynamics, physical effects of pressure differentials across the reactor core, shock or rarefaction waves, and cost differentials are investigated. The results indicate that larger pressure differentials, due to fluid movement and rarefaction wave generation, are experienced across a 2500 psig pressurized water reactor core during the expulsion of fluid from the primary reactor system than a 1200 psig system for larger pipe ruptures. These results in turn lead to the conclusion that mechanical damage of the reactor core and internals are more likely during the loss of fluid from the high pressure system. The cost savings available by building the lower pressure system do not warrant accepting the uncertainty in system behavior when performing the experiment at 1200 psig and extrapolating the results back to 2500 psig. It is the opinion of The Babcock & Wilcox Company that a 2500 psig LOFT system should be built. (auth)

13186 (CONF-187-95) EFFECT OF EDDY DIFFUSION ON TEMPERATURES IN A FIXED-BED, PARTICULATE-FUELED NUCLEAR REACTOR. James J. Barker and Robert F. Benenati (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract [AT(30-2)-Gen-16]. 18p.

From American Nuclear Society Meeting, New York, Nov. 1963.

An analysis was made of the possible effects of eddy diffusion on the temperature distribution in a sodium-cooled, settled-bed reactor. Some computer calculations are presented. It is concluded that eddy diffusion has a negligible effect in a large reactor with small fuel particles, but could have appreciable effects in small reactors with relatively large fuel particles. The calculation method can be applied to chemical reactors. (D.L.C.)

13187 (EURAEC-959) IMPROVEMENT OF BOILING WATER REACTOR STABILITY THROUGH MEAN SQUARE ERROR MINIMIZATION OF BOILING NOISE. Quarterly Progress Report No. 2, October 1, 1963–December 31, 1963. Lynn E. Weaver (Arizona. Univ., Tucson. Engineering Research Lab.). Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(11-1)-1311. 79p.

The application of design equations formulated for an optimum system based on minimization of the system bandwidth to a representative transfer function model of EBWR is demonstrated. It is shown that a model for a reactor control system can be determined that gives considerable reduction in the mean squared value of the reactor noise, and also yields very good transitive response characteristics. The relation between the system bandwidth and corresponding mean squared value of reactor noise is shown. Gain scheduling and adaptive control techniques are discussed as possible methods for solving the noise minimization problem in boiling reactor systems. (auth)

13188 (NAA-SR-Memo-9197) NAA PROGRAM DESCRIPTION. AIREK 3—GENERALIZED PROGRAM FOR THE NUMERICAL SOLUTION OF SPACE INDEPENDENT REACTOR KINETICS EQUATIONS. L. R. Blue and M. Hoffman (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 1963. Contract AT-11-1-GEN-8. 58p.

The FORTRAN program AIREK III solves the conventional reactor kinetics equations and a generalized feedback equation. The numerical method, features, input data and restrictions are described. Input and output for a sample case are included, as well as the program listing. (D.C.W.)

13189 (UCRL-7606) TRANSIENT REACTOR AEROTHERMODYNAMICS. Howard C. Rodean (California. Univ., Livermore. Lawrence Radiation Lab.). Nov. 18, 1963. Contract W-7405-eng-48. 51p.

The transient aerothermodynamic processes in a gas-cooled reactor are described in a simplified manner. The transient heat balance equation for an element of a single reactor channel is derived in terms of aerothermodynamic time constants, and typical analytic solutions for transients are presented. This equation is used in generating the time-dependent equation for the channel exhaust gas temperature. The single-channel analysis is extended to multiple channels. A method for determining the approximate transient temperature envelopes for various reactor components is presented. The effects of aerodynamic and thermal coupling between different reactor channels are illustrated. Some of the simplifying assumptions are investigated with respect to the conditions under which they are valid. (auth)

13190 (WCAP-6058) CNCR-2—A ONE-DIMENSIONAL FEW-GROUP DEPLETION CODE FOR THE IBM-7090, WHICH INCLUDES THE EFFECTS OF WATER DENSITY VARIATIONS ON NEUTRON MODERATION. S. M. Hendley and R. A. Mangan (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Jan. 1964. Contract AT(30-1)-3017. 115p.

CNCR-2, a modification of CNCR-1 that solves the few-group, one-dimensional diffusion equation in combination with a pointwise burnup calculation to determine a reactivity-lifetime relationship, is described. Spatial variations in water density due to coolant heating are included. The modifications include a calculation of the dependence of the resonance escape probability in U^{238} on the spatially varying water density, a calculation of the effect of power density on the resonance escape probability in U^{238}, and a water density dependent poison search. (auth)

13191 HEAVY WATER REACTORS FIND WORLD FAVOR. J. S. Foster (Atomic Energy of Canada Ltd., Toronto). Can. Chem. Process., 46: 43-5(Nov. 1962).

Developments in heavy water reactors are discussed. Design, coolants, operating experience, and economics are considered. The advantages of heavy water reactors over other types of reactors are discussed. (P.C.H.)

13192 NEW PROCEDURE FOR RAPID STARTUP OF NUCLEAR REACTORS. Jacky Weill and Jacques Furet. Compt. Rend., 258: 887-8(Jan. 20, 1964). (In French)

The system described requires no knowledge of the negative reactivity of the reactor and no particular ar-

rangement in the reactor. Only a system for measuring the relative fission rate is needed. Analysis of the procedure on an analog computer shows very substantial reduction in the time required to go from an initial reactivity level to a higher level. (D.C.W.)

13193 THE NOISE FIELD OF A REACTOR. M. N. Moore (Univ. of Florida, Gainesville). 27p. (CONF-332-10)

From Symposium on Noise Analysis in Nuclear Systems, Gainesville, Fla., Nov. 1963.

The correlation problem of linear noise fields was formulated and two general theorems were proved. These theorems relate noise and cross spectra to source spectra via field dispersion functions in a manner analogous to the theorems in simple noise theory relating the noise and cross spectra to the source spectrum via the transfer function. This demonstrates further the analogy between dispersion functions and transfer functions. The principal complication is that the dispersion function contains, as a parameter, a quantity that is different for each vibrational mode. Thus, instead, as in the simple case of there being one source spectrum and one noise spectrum, there is now a source matrix, a noise matrix, and a cross matrix. The nature of these matrices for various types of source fields of interest in reactor work was studied. This was undertaken to provide insight into reactor noise fields and to come to grips with the experimental problem. (auth)

13194 EMERGENCY SEALING DEVICES FOR APERTURES. (to the State of Israel, Minister of Defence). British Patent 947,564. Jan. 22, 1964. Priority date Aug. 28, 1961, Israel.

A fast and effective emergency sealing device, especially applicable to apertures in nuclear reactors, is patented. A drop flap with a spherically faced rim is mounted above a sealing ring around the aperture. The flap can be automatically released and falls under gravity into sealing engagement with the ring. The flap is mounted to permit some swivelling so that it will center itself with respect to the sealing ring. Various methods of holding the flap in its open and closed positions are described. (M.P.G.)

13195 IMPROVEMENTS IN OR RELATING TO SOLID-MODERATOR STACK FOR NUCLEAR REACTORS. Georges Lemesle, Roger Manes, and Pierre Rouge-Cite (to Commissariat à l'Energie Atomique). British Patent 948,316. Jan. 29, 1964. Priority date Nov. 20, 1961, France.

The design of a solid-moderator stack formed of identical prismatic rods is patented. The lateral faces of the rods have successive ribs and grooves, which couple with corresponding grooves and ribs in the faces of adjacent rods. The rods are designed so that the distance between the longitudinal axis of a rod and the bottom of each groove is equal to the distance between the axis and the base of each rib. The faces of the rods may be curvilinear, the concave ones having a rib and the convex ones having a groove. An alternate design has flat lateral faces with hollowed-out or raised splined portions. The rods have greater strength than rods of conventional design and are more economical to manufacture, since less moderator material needs to be machined off the original cylinder. (M.P.G.)

Auxiliaries and Components

Refer also to abstracts 12313 and 12458.

13196 (CONF-243-47) A CLADDING FAILURE MONITOR FOR LIQUID METAL-COOLED REACTOR SYSTEMS. R. R. Smith and C. B. Doe (Argonne National Lab., Idaho Falls, Idaho). [1963]. Contract [W-31-109-eng-38]. 14p.

From American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963.

A cladding failure monitor using the principle of detection of rare gas fission products in the cover gas system of liquid metal-cooled reactors, was developed which efficiently discriminates against Ar^{41}. This discrimination is accomplished by electrostatic precipitation of the rare gas daughter nuclides; since K^{41}, the daughter of Ar^{41}, is not radioactive, the activity of the precipitation is chiefly due to decay of various Rb and Cs fission products. The monitor equipment is described. Results of monitor testing in EBR-I are reported; a simulated fuel rod failure experiment was made which shows that the charged-wire cover gas monitoring principle should be useful in other sodium-cooled fast reactor systems. (D.L.C.)

13197 (WCAP-3727) CONTROL ROD REQUIREMENTS IN A CHEMICAL SHIM CORE. D. L. Miller (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Aug. 1963. Contract AT(30-1)-3064. 16p.

The concept of chemical shim in a water moderated reactor permits a significant reduction in the amount of reactivity that must be controlled by movable control rods. A set of criteria that can be applied to determine the control rod requirements of a chemical shim controlled core is suggested and applied to a typical pressurized water reactor design. (auth)

13198 (AEC-tr-6326) MECHANICAL PUMPS FOR 1- AND 10-MW TEST LOOPS. J. Baumier [France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses]. Translated for Oak Ridge National Lab., Tenn., from report DRP/ML/FAR R/100. Feb. 20, 1962. 62p.

Descriptions are given of four centrifugal type pumps designed for 10- and 1-Mw test loop mockups of the cooling circuits of the Rapsodie reactor. The results of preliminary tests with Na and NaK are given. Modifications proposed for improving the pumps are described. (D.L.C.)

13199 DEPENDENCE OF THE HEAT RELEASE ON THE COMPOSITION OF AN IRON–WATER THERMAL SHIELD. K. K. Popkov, L. N. Tabolina, and S. A. Tsvetkova. At. Energ. (USSR), 15: 516-17(Dec. 1963). (In Russian)

In order to determine the correlation between the heat released in the reactor vessel and the composition of the thermal shield containing Fe and water, calculations were carried out on a schematic system consisting of the thermal shield, the vessel of a water-cooled, water-moderated reactor and the water of the primary shield. Homogeneous mixtures containing 10, 20, 30, 50, 70, 80, and 90 volume % of Fe + water were considered. It was found that at low Fe concentrations the heat generated is due primarily to γ radiation from the core; with increasing Fe concentration, the contribution of the γ radiation decreases, following closely the exponential expression with the exponent of about $7.8 \times 10^{-2}\ (\%)^{-1}$. The component due to radiative γ capture first decreased with the Fe content up to about 65 to 70%, after which it increased; this was considered due to changes in the absorbing properties of the Fe–water system with respect to neutrons; the increase of the relaxation length of fast neutron also played a role. The minimum heat release lays at a Fe concentration of about 70 volume %. (TTT)

13200 TRANSFER METER FOR NUCLEAR REACTORS. J. Pottier. p.310-15 of "Automatic and Remote

Control. Vol. III." London, Butterworths, 1961. (In French)

A transfer meter was designed to obtain the transfer function of a reactor by relating the resulting modulation of the neutron flux, as given by an ionization chamber, for instance, to small periodical perturbations applied to one of the parameters of the reactor. Difficulties arose in the low-frequency range of measurements (for frequencies of a few cycles per min), chiefly because of the comparatively high random fluctuation rate of the observed mean neutron flux. A theoretical discussion of the precision of the method is presented, taking into consideration the time duration of the measurement and the signal-noise ratio of the neutron flux. It is shown that in order to optimize the results of the measurement, an electromechanical analog of the Fourier analysis algorithm is necessary. The way such an analog was achieved and its performances are discussed. For frequencies below 1 Hz, in usual practice, the accuracy of measurement was 0.5% for the amplitude and 15 min for the phase of the fundamental. (auth)

13201 A METHOD OF MATHEMATICAL SIMULATION OF PHYSICAL PROCESSES WITHOUT LIMITING THE RANGE OF PARAMETER CHANGES—APPLICATION TO PROBLEMS OF AUTOMATIC CONTROL OF NUCLEAR REACTORS. N. Filipczak, W. Filipczak, and T. Zielinski. p.389-94 of "Automatic and Remote Control. Vol. IV." London, Butterworths, 1961.

A method of automatic scale change in an analog computer at the moment when the parameter exceeds the preset range limit, which is based on a change in the definite voltage ratio in the simulator capacitors, correspondingly subdivided, is described. The application in the analysis of the startup processes of a uranium reactor with thermal neutrons is given as an example. (auth)

13202 CRITICAL COMPARISON OF NUCLEAR REACTORS WITH VARIOUS TYPES OF CONTROLLER. U. Kaczmarek. p.398-402 of "Automatic and Remote Control. Vol. IV." London, Butterworths, 1961.

The types of controllers compared are either simulated by the computer or actually connected to the computer. The various control systems were simulated (unsteady control, follow-up control, control with several disturbances) and the following three controls were investigated: constant output temperature of the primary cooling fluid, constant medium temperature of the cooling fluid, and constant pressure in the secondary loop. The efficiency of the various control systems is compared. (auth)

13203 OPTIMAL CONTROL ANALYSIS OF NUCLEAR REACTORS. Richard John Hermsen. Thesis, Madison, Wis., Univ. of Wisconsin, 1963, 241p.

New techniques of nuclear-reactor-control analysis and synthesis were developed, based on use of powerful procedures recently introduced and now being developed in the general domain of automatic control theory. These techniques are illustrated with numerical examples using values of parameters, which characterize typical nuclear reactor systems. The basic theory of synthesis of optimally-design linear nuclear-reactor control systems is developed, using several different procedures. (M.P.G.)

13204 NEUTRON FLUX MEASURING APPARATUS. Gilbert Ronald Bainbridge (to United Kingdom Atomic Energy Authority). British Patent 947,104. Jan. 22, 1964. Filed Oct. 27, 1961.

An apparatus for measuring the neutron flux within a reactor by measuring the activity induced in a fluid by neutron irradiation is patented. An irradiation unit of low-neutron-absorbing characteristics can be inserted into any empty fuel channel. The unit contains transverse porous partitions or some other device to slow down the flow of fluid through it. Fluid passes through the unit and is withdrawn from the reactor, and its activity is measured. The reactor coolant fluid may be used, or a separate fluid may be circulated through the irradiation unit. Suitable neutron-activatable gases are A and CO_2. Induced activity in the fluid due to its passage from the activation unit to the monitor is negligible, since the fluid remains in the unit much longer than it does in the outlet tubes. The irradiation unit may be moved along the fuel channel to scan the variations in neutron flux in the core. (M.P.G.)

13205 FUEL ELEMENT HANDLING DEVICE FOR A NUCLEAR REACTOR. (to Commissariat à l'Energie Atomique). British Patent 947,217. Jan. 22, 1964. Priority date May 19, 1959, France.

A fuel-handling plug, which fits into an aperture in a reactor shield, is patented. The plug contains shielding material, a grab for fuel elements, and a flexible coupling, which passes from the grab, through a nonrectilinear passage and a liquid or gas seal in the plug, to a winder on the plug. A power unit for the winder is also on the plug, and a guide skirt on the plug defines a passage for the fuel element being removed from the reactor. The fuel-handling plug is replaced by solid plugs after handling operations are completed. (M.P.G.)

13206 NUCLEAR REACTOR DUCT CLOSURE DEVICE. (to Commissariat à l'Energie Atomique). British Patent 947,592. Jan. 22, 1964. Priority date May 5, 1959, France.

A device for opening and closing reactor ducts to maintain shielding and permit loading during reactor operation is patented. Two drums, each long enough to shield against radiation, are mounted in a tube, which extends through the reactor shield. The drums contain lengthwise passages, which can be aligned with one another and with reactor ducts by rotating the drums through different angles within the tube. A single closure device may be used for a number of reactor ducts. When a duct is open by being aligned with passages through both drums, all the other ducts are closed by being aligned with the solid part of at least one drum. (M.P.G.)

13207 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Frederick John Rogers and Philip Cloudesley Warner (to Atomic Power Constructions Ltd.). British Patent 947,775. Jan. 29, 1964. Filed June 16, 1959.

The design of a support structure for the core assembly of a solid-moderator reactor is patented. The structure consists of a horizontal grid secured to an annular outer support member encircling the grid. A smaller support ring is parallel to and below the outer support member and forms the top of a supporting skirt inside the reactor pressure vessel. The grid is held above the support ring by vertical struts fastened to the ring, and the outer support member is held above the ring by sloping radial struts fastened to the ring and the support member. The lattice of the grid may be any regular array that matches the lattice of the core assembly, so that fuel channels are not obstructed. (M.P.G.)

13208 IMPROVED APPARATUS FOR TRANSFERRING A LOAD BETWEEN TWO FLUID-CONTAINING RESERVOIRS. (to Bureau d'Etudes Nucleaires en Abrege B.E.N.). British Patent 948,168. Jan. 29, 1964. Priority date Jan. 5, 1960, Belgium.

An apparatus especially useful for transferring spent reactor fuel elements is patented. The fluids in the storage reservoirs are used to move the elements between the reservoirs in a manner similar to pneumatic conveying devices. A horizontal tube connects the reservoirs near the bottom and contains a carriage to hold the fuel elements. The carriage has a piston at either end. A system of pipes, pumps, cocks, and closure valves connects the reservoirs and the transfer tube, making it possible to alter the fluid pressure on the piston and push the carriage from one reservoir to the other. (M.P.G.)

13209 A DEVICE FOR ANCHORING AND EXTRACTING PLUGS IN AND FROM FUEL CHANNELS OF NUCLEAR REACTORS. Pierre Cousseran, Jean Marc Hassig, and Roland Roche (to Commissariat à l'Energie Atomique). British Patent 948,233. Jan. 29, 1964. Priority date Aug. 16, 1961, France.

An anchoring and extracting device for reactor-fuel-channel plugs is patented. The device meets safety requirements and can be used a great many times without failure. Pawls that lock the plug to the fuel channel are pivoted on a recessed part of the plug. A clamp with radially movable levers can be lowered onto the plug and positioned so that the levers release the pawl-locking mechanism. The plug can then be withdrawn with the clamp. The plug can be replaced by reversing the operation, and the clamp can not be disengaged from the plug until the plug is locked in the fuel channel. Details of the design are described. (M.P.G.)

13210 IMPROVEMENTS IN CONTROL ROD ASSEMBLIES FOR NUCLEAR REACTORS. (to General Dynamics Corp.). British Patent 948,890. Feb. 5, 1964. Priority date Aug. 2, 1961, United States.

A control rod assembly is described that consists of an elongated support rod with spacer elements affixed, a generally cylindrical section of neutron absorber coaxially disposed on the support rod intermediate to adjoining pairs of spacer elements, and a flexible metal disk, intermediate to each spacer element and the adjoining end of the section of neutron absorber, in position to cushion the section against shocks and thermal expansions. The entire rod is contained in a guide tube. (R.E.U.)

13211 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Stefan George Bauer (to Rolls-Royce Ltd.). British Patent 948,909. Feb. 5, 1964. Filed June 19, 1959.

A reactor moderator mass is described that consists of light water and lead or magnesium with the area ratio of lead or magnesium to light water varying from region to region in the moderator. Control of the reactor may be initiated by varying the ratio. The lead or magnesium is formed concentrically to the coolant tubes containing the fuel elements with the annular spaces between the lead or magnesium and tubes being filled with light water. The system is applicable to low-temperature moderators. (R.E.U.)

13212 MACHINE FOR EXCHANGING CONTROL ROD ASSEMBLIES IN A NUCLEAR REACTOR. (to Allmanna Svenska Elektriska Aktiebolaget). British Patent 949,013. Feb. 5, 1964. Priority date June 30, 1961, Sweden.

A device is described for inserting and withdrawing control rods from the underside of heavy water reactors. Means are provided for applying a sealing plug and for disengaging the control rod assembly and connecting it to the withdrawing mechanism. Shielding is provided to protect the active control rod assemblies. (R.E.U.)

13213 IMPROVEMENTS IN OR RELATING TO SUPPORTING STRUCTURES FOR PRESSURE VESSELS AND THE LIKE. (to General Dynamics Corp.). British Patent 949,020. Feb. 5, 1964. Priority date Oct. 30, 1961, United States.

An apparatus is described for a supporting a flanged pressure vessel within a main housing so that radial and bi-directional movement of the vessel is allowed to relieve thermal forces of expansion and contraction. An annular support ring is secured to and extends radially outward from the outer peripheral surface of the vessel. A secondary support is mounted on the main housing with provisions for mating contact with the annular support ring. (R.E.U.)

13214 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Eugen Glueckauf, Ronald Henry Flowers, and Frederick Charles William Pummery (to United Kingdom Atomic Energy Authority). British Patent 949,117. Feb. 12, 1964. Filed Dec. 20, 1961.

An apparatus is described for removing fission product metals from the gas coolant stream of a dispersion-fueled reactor. A filter bed of glass-like discrete solid bodies is provided outside the core of the reactor and receives the gas before the heat exchangers. The glass bodies of the filter bed are 75% SiO_2, 15% K_2O, and 10% CaO by weight, and possess high diffusion coefficients for the fission products. (R.E.U.)

13215 IMPROVEMENTS RELATING TO SEALING DEVICES. Antoni Roginski (to English Electric Co. Ltd.). British Patent 949,162. Feb. 12, 1964. Filed June 24, 1959.

A plug device is described for sealing a bore or channel of a cylindrical vessel containing fluid at high temperature and pressure. The body portion is arranged to support a wedge that is activated by radial motion of the body of the device. The wedge in turn causes axial movement of the device, which compresses a dished annular metal gasket. Application is made to reactor standpipes. (R.E.U.)

13216 IMPROVEMENTS RELATING TO FUEL ELEMENT TRANSFER DEVICES FOR NUCLEAR REACTORS. George Fritz Werner Adler and Kenneth Arthur Billingham (to English Electric Co. Ltd.). British Patent 949,458 Feb. 12, 1964. Filed June 15, 1959.

A transfer device is designed for loading and unloading fuel elements of a reactor. The device comprises a main transfer tube, a movable transfer tube incorporating at least one hinged joint and arranged for movement from axial alignment with the main tube to positions spaced transversely from the main tube, and a grabhead cable member within each hinged joint. Each guide member is coupled to the joint so that, when the joint is unflexed, the guide member allows free movement of fuel elements through the joint, whereas when the joint is flexed, the guide member moves automatically to a position to guide the cable round the joint. Further features of the device are also described in British Patent 949,459. (D.L.C.)

13217 IMPROVEMENTS RELATING TO FUEL ELEMENT TRANSFER DEVICES FOR NUCLEAR REACTORS. Kenneth Arthur Billingham (to English Electric Co. Ltd.). British Patent 949,459. Feb. 12, 1964. Filed June 15, 1959.

A transfer device is designed for loading and unloading fuel elements of a reactor. The device comprises a main transfer tube and a movable transfer tube arranged for movement between a coaxial position and positions spaced transversely from the axis of the main tube. The movable

tube is mounted on the main tube through links arranged to maintain the axis of the movable tube parallel to that of the main tube. An actuating member for the movable tube is also mounted on the main tube and coupled to the movable tube through a hinged intermediate tube. Further features of the device are also described in British Patent 949,458. (D.L.C.)

13218 IMPROVEMENTS IN OR RELATING TO ELEMENTS FOR INFLUENCING THE NEUTRON BALANCE IN NUCLEAR REACTORS. (to Siemens-Schuckertwerke AG). British Patent 949,780. Feb. 19, 1964. Priority date Mar. 21, 1959, Germany.

A control element for regulating neutron balance in a reactor was developed, which consists of two cooperating neutron control means displaceable relative to one another between a first extreme position and a second extreme position. Each control means includes a support member adapted to support one or more neutron balance disturbing members each of which consists of at least two materials that disturb the neutron balance of the reactor in different ways and are disposed in such a manner that, when the control element is in use, in one extreme position of the element there occurs minimum exposure of one of the substances to neutrons and in the other extreme position there occurs minimum exposure of the other substance to neutrons. The element is constructed in the shape of a conventional fuel element. (M.C.G.)

13219 CHARGING MACHINE FOR NUCLEAR REACTORS. Johann Ropers and Robert Weber (to Siemens-Schuckertwerke AG). German Patent 1,156,902. Nov. 7, 1963. Filed Aug. 5, 1961.

The charging machine described is provided with a demountable attached coolant medium pump. When the charging unit is radioactively contaminated the pump can be exchanged with the help of remote handling equipment. The holding device for the pump comprises a free-standing, hinge-type pivot attached to the charging machine and at least one flange rigidly joined to the pump that is supported by the pivot. (Gmelin Inst).

13220 CONSTRUCTION OF A SOLID MODERATOR FOR NUCLEAR REACTORS. Georges Lemesle, Roger Martin, Marcel Monteil, and Pierre Rouge (to Commissariat à l'Énergie Atomique). German Patent 1,158,190. Nov. 28, 1963. Priority date Mar. 11, 1960, France.

The moderator is constructed of pillared elements that have square cross sections and axial channels. The moderator pillars are arranged in parallel columns that are held together by ties. The moderator structure is provided on its outside with a framework construction that is a rigid cage attached to the floor structure which supports the moderator columns. The cage consists of pillars that are joined to the outer columns of the moderator structure in the same way as the columns are joined together. (Gmelin Inst).

13221 CHARGING MACHINE FOR GAS- OR LIQUID-COOLED NUCLEAR REACTORS. Hermann Kumpf, Robert Weber, Johann Ropers, and Frnaz Schubert (to Siemens-Schuckertwerke AG). German Patent 1,158,642. Dec. 5, 1963. Filed June 30, 1961.

The charging machine, which may be moved by its own weight as required above the reactor and which makes a seal with one of the coolant channels, comprises a pressure tank, a magazine for the reception, and a lifting mechanism for the transport of fuel elements and tools. The tools disposed in the guide channels of the magazine are automatically coupled to the drive mechanisms by rotation of the magazine to the lifting mechanism and by lowering into the guide channel. As the guide channels are equal the tools may be disposed in any channel. (Gmelin Inst.)

13222 NUCLEAR REACTOR WITH PRESSURE TUBES. Franz Schreiber and Rudolf Roesler (to Siemens-Schuckertwerke AG). German Patent 1,159,573. Dec. 19, 1963. Filed Apr. 16, 1960.

The nuclear reactor is provided with pressure tubes that are connected with curved header tubes by connecting pipes arranged in parallel planes. The pipes each of which connects one pressure tube with a ring header are evenly distributed along the circumference of the ring header. This arrangement of the connecting pipes results in a manifold repetition of the various shapes of these pipes so that their production is simplified. Each of the pipes is easily accessible and exchangeable. (Gmelin Inst.)

13223 METHOD OF OPERATING A NUCLEAR REACTOR. Stuart McLain. U. S. Patent 3,119,744. Jan. 28, 1964. Filed Nov. 30, 1959.

A method is described for safe handling of materials during insertion in a reactor. A radiation shield plug is provided for an access opening in a reactor whose shielding is in the form of two parts. The need for separate coffins during the handling of materials is eliminated; the outer shield functions as a coffin. (R.E.U.)

13224 DEVICES FOR SUPPORTING AT LEAST THE SOLID MODERATOR OF A NUCLEAR REACTOR HAVING VERTICAL CHANNELS. Georges Lemesle, Roland Roche, and Pierre Rougé (to Commissariat à l'Energie Atomique). U. S. Patent 3,119,746. Jan. 28, 1964. Priority date Nov. 9, 1957, France.

A vertical-channel reactor moderator support is described that provides for flexible fluid-tight connection of the channel bottoms to the corresponding coolant conduits. (R.E.U.)

13225 POSITION INDICATING DEVICES. Joseph Raymond Pendleton and Richard Smart (to United Kingdom Atomic Energy Authority). U. S. Patent 3,121,146. Feb. 11, 1964. Priority date June 12, 1959, Great Britain.

A device composed of two magnet systems for indicating that a selected relative position is occupied by two relatively movable members is described. Application is made to indicating the limit positions of reactor control rods. (R.E.U.)

13226 SUPPORT STRUCTURE. Kenneth A. Trickett and Merle R. Grassman (to U. S. Atomic Energy Commission). U. S. Patent 3,123,328. Mar. 3, 1964.

A structure for supporting an upright reactor pressure vessel so as to accommodate both horizontal radial expansion and minor bidirectional horizontal linear movement of the entire vessel is described. The uppermost of three stacked horizontal annular support rings is affixed to the vessel's periphery while the lowermost serves as a stationary base. Between the upper two rings, a system of radial keys and slots affords only horizontally radial movement between those rings; between the lower two rings, a system of linearly aligned keys and slots affords only horizontally linear movement between the rings. (AEC)

13227 CONTROL ROD POSITIONED BY FLUID FLOW THROUGH THE ROD CHANNEL. J. W. Michel (to U. S. Atomic Energy Commission). U. S. Patent 3,123,532. Mar. 3, 1964.

A control rod drive system wherein a vertically movable rod is positioned by fluid flow is described. A float mem-

ber, connected to the control rod, is positioned in an outwardly tapered tube that is coaxially mounted atop the control rod channel. The float member changes its vertical position in response to varying flow rates through the tapered tube thereby causing a corresponding change in the vertical position of the connected control rod. (AEC)

13228 PRESSURE RELIEF DEVICE FOR NEUTRONIC REACTORS. Allen E. Galson (to U. S. Atomic Energy Commission). U. S. Patent 3,123,533. Mar. 3, 1964.

The use of a venturi in combination with a reactor outlet nozzle to provide controlled pressure relief in the event of rupture of the coolant outlet line exterior of the reactor is described. The venturi is constructed to ensure that gas flowing through it will reach sonic velocity upon downstream rupture or pressure loss, thus isolating the reactor from the severe forces that would result from too sudden a pressure reduction within the reactor vessel. (AEC)

13229 CONTROL ROD DRIVE. B. C. Hawke and I. C. Thompson (to U. S. Atomic Energy Commission). U. S. Patent 3,124,513. Mar. 10, 1964.

A control rod drive especially devised for maritime gas-cooled reactor application is described. A control rod push tube, in a normal operational mode, is moved longitudinally by a lead screw maintained in threaded relationship therewith by a ball-detent latch. In an emergency shutdown mode, impressed fluid pressure serves first to delatch the push tube, and then positively thrust it as a piston to a fully inserted position. A locking hook, which thereupon retains the push tube in fully inserted position, is adapted to be unlocked automatically by a relatching of the tube to the lead screw upon reversion to normal mode operation. Fluid cushioning of the piston when bottoming and other beneficial features are included. (AEC)

13230 CORE REFLECTOR FOR NUCLEAR REACTOR. Stanley L. Koutz, Wilbert A. Kalk, and Frederick B. Nimtz (to U. S. Atomic Energy Commission). U. S. Patent 3,124,514. Mar. 10, 1964.

A core structure for firmly supporting an array of clustered, vertical, elongated fuel elements in a gas-cooled reactor is described. The array is encircled by two concentric ceramic walls, each comprised of elongated vertical segments admitting of radial movement, with the inner wall provided with vertical battens to form a gas barrier. A pressure vessel envelopes all. The influent coolant gas first enters the plenum formed between the pressure vessel and outer wall before later coursing vertically among the fuel elements; in operation the resulting pressure differential radially compresses the inner wall so as to firmly clamp upon the fuel array, while during shutdown the cessation of coolant flow automatically relaxes the clamping to afford ready vertical withdrawal and insertion of individual fuel elements. Individual "teeter-totter" supports for corresponding segments of inner and outer walls afford continuous plenum sealing, while accommodating extensive vertical thermal expansion of the segments. (AEC)

13231 FUEL LOCATING AND SUSPENDING SYSTEM FOR NEUTRONIC REACTOR CORE. J. Foster, A. P. Fraas, and A. M. Perry (to U. S. Atomic Energy Commission). U. S. Patent 3,125,760. Mar. 17, 1964.

A system for locating and suspending fuel elements within the vertical channels penetrating a reactor core of solid neutron moderator is described. Rigid fuel hangers are slidably passed along longitudinal recesses spaced about the channel peripheries and rotated into appropriate intersecting grooves that are inclined downwardly away from the recesses. The grooves provide both vertical and angular support to the rigid fuel hangers and their corresponding fuel elements. (AEC)

Crititicality Studies

13232 (BAW-207) SAFETY. A SIMPLIFIED CRITICALITY PROGRAM. D. B. Wehmeyer (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). June 1963. 15p.

The SAFETY Program calculates the criticality of heterogeneous or homogeneous water moderated and reflected reactors, using a modified two-group theory for a point reactor. For a given fuel type, the program calculates the reactor parameters and critical sizes for the complete range of water moderation. The program was written primarily for nuclear safety use in the calculation of critical ranges for fuel processing, storage, and shipment. However, the results are generally applicable to room temperature water moderated lattices, and the results have been correlated carefully with critical experiment data. The program is coded in FORTRAN for the Philco 2000 computer. Typical running time is about a minute. (auth)

13233 (BNL-823(p.1-19)) REACTOR PHYSICS DIVISION. J. Chernick and H. Kouts (Brookhaven National Lab., Upton, N. Y.).

Research was devoted to multi-velocity transport theory in homogeneous systems, to lattice physics, and to reactor kinetics. Research in transport theory proceeded along two paths; in one, attempts were made to develop accurate, quasi-analytical methods for the solution of space-dependent problems involving thermal neutrons. The methods were tested on the thermal Milne problem with simple scattering kernel. In the other, calculations are being made to determine time decay constants and diffusion lengths for several models of crystalline moderators. Research was concerned with the analysis of a "two-temperature" model, into which two different laws of cooling were incorporated. In preparation for the planned measurements in Th–U^{233} lattices, a review is being made of both the microscopic and macroscopic data available on resonance capture in Th. The study of systematic errors in the inference of buckling from BNL exponential experiments was completed. The theoretical analysis of the slightly enriched plate fuel element exponential experiments was completed, but the validity of the lattice anisotropy measurement in these lattices is still being studied. Measurements of the reactivity effect of neutron return, and of the prompt neutron generation time by pulsed source techniques, were completed by using the Minimum Reflection Critical Facility (MRCF). Uranium–Graphite Critical Assembly No. 2 was dismantled and Assembly No. 3 was constructed and brought critical. The calculated κ excess requirements of the High Flux Beam Reactor were raised from 10.7 to 13.4%. Two cores were constructed and run, with κ excess of 10.4 and 13.2%. Power maps, κ excess, holddown, flux distributions, and various reactivity coefficients were measured on each core. The experiments on neutron moderation by cold media were continued, with neutron spectra measured from the empty experimental facility and from various samples at 100 and 300°K. The resonance capture was measured in lattices of the 0.250-in.-diam U metal rods, 1% enriched, with 1:1, 1.5:1, 2:1, and 9:1 H_2O:U volume ratios. Measurement with the 3:1 H_2O:U volume ratio was begun. Preparations for measurements of reactor physics parameters with $U^{233}O_2$–ThO_2 and

UO_2-fueled uniform lattices in light water were made. Tests were conducted with a d-c Hg generator in the reciprocating liquid piston MHD studies. A 60% component efficiency was obtained at 12,600 gauss. The data showed little scatter; the voltage and current curves were linear functions of velocity to within ±5%. Hydraulic experiments with a water piston showed that at 1-g deceleration, the piston surface is Rayleigh-Taylor unstable and starts to splash. The oscillations were damped out by using a packed bed in the deceleration region; a 10-g deceleration was reached at almost 3 cycles/sec with no piston breakup. At this frequency, with K as the working fluid, the necessary liquid inventory is only 0.27 lb/kw, where 1.0 lb/kw is acceptable. System studies indicated that an optimum cycle operates between 2340°F (430 psia) and 1400°F (15 psia) with 18% ideal efficiency for constant pressure expansion. Plasmas of KBr seeded with He, Ar, and Ne were generated by an r-f coil in preparation for conductivity measurements with UBr_3 in the pulsed plasma reactor studies. Thermodynamic cycle calculations were performed for the system $Pb-PbBr_2-Br_2(g)$ in a closed cycle converter. At a system pressure of 1 atm and the cells at temperatures of 380 and 920°C, respectively, an ideal Carnot cycle efficiency of 45% was obtained; due to differences in heat capacities between reaction products and reactants, an upper limit of 42% existed. A fluorocarbon elastomer, Viton A, was found to be resistant to Br_2 gas at room temperature; it swelled excessively and hardened at 90°C. An apparatus was constructed from K Monel, using K Monel valves with Teflon seats, for use in conjunction with a liquid Br_2 constant temperature bath as source for dry, high-purity Br_2 gas. Time-dependent calculations are being checked out for THORCYC, a fuel cycle analysis code for $Th-U^{233}$ fast breeder reactors. A revised version of THORCYC was prepared and checked out. Calculations were performed for UF_6-fueled reactor cores moderated by HF and DF near their critical temperatures. HF-moderated cores were assumed to be at an average temperature and pressure of 300°C and 3940 psia, and DF-moderated cores at 260°C and 9800 psia, respectively. The fission product release into Na from ⅛-in.-diam unclad UC spheres by diffusion and recoil was calculated by steady-state operation for Br, Kr, and Sr (decay chains of mass numbers 83 to 97), and for Te, I, Xe, and Cs (decay chains of mass numbers 127 to 144). The predominant mode of release for the conditions of the radial flow Settled Bed Reactor case was by recoil. Total moles released varied from 10^{-11} for Xe^{143} to 10^{-4} for Xe^{135} at a reactor power level of 825 Mw(t). An out-of-pile engineering study was started on the use of Li for spectrum control in high-temperature, liquid-metal-cooled reactors (e.g., Na-cooled Settled Bed Reactor). An IBM 7090 computer program was designed to determine the temperature fields that exist within the interior of a thin fuel element. Preliminary results of four cases treated indicated that it may be possible to obtain coolant gas temperatures higher than those of the fuel element in systems where the radiating surfaces have high thermal emissivities (close to black bodies), while simultaneously releasing a large fraction of fission fragments directly into the coolant gas stream. Solubility studies of Fe and H_2O in o-terphenyl were completed. At temperatures of 225, 300, and 375°C, respectively, no dissolved Fe was found (limit of detection, 0.12 ppm). Also, no effect due to O_2 or H_2O in the Ar cover gas was found. Water, on the other hand, was found to be soluble at these temperatures, but the data scattered considerably. No corrosion or mass transfer was found in tilting-furnace capsules in which specimens of 304 stainless steel, mild steel, carbon steel, 2S Al, Al-288, and SAP were exposed to o-terphenyl and p-terphenyl at temperatures of 410, 375, and 270°C. Studies of the radiolytic and pyrolytic stability of several polyaromatic compounds were completed with exposures in the BNL reactor at 400, 425, and 450°C. No correlation between stability and resonance energy was found. Correlations with ionization potentials, absorption bond energies, and total number of π electrons were also investigated but without success. There did appear, however, to be a correlation of stability with both the electron affinity and with singlet-triplet excitation energies. The Neutron Cross Section Compilation Group began to prepare data for storage in its magnetic tape filing system. The Reactor Cross Section Evaluation Group continued its studies of the statistical distributions of the spacings and widths of energy levels, not only in actual nuclei but also in atoms and in simple quantum systems generally. The optical model with a spherical well was applied successfully to fit elastic and inelastic neutron scattering data on a number of heavy elements which are known to have some of the properties of nonspherical nuclei. (auth)

13234 (CONF-187-35) BUCKLINGS, DISADVANTAGE FACTORS, AND δ^{28} MEASUREMENTS IN SOME UNDERMODERATED SLIGHTLY ENRICHED CORES. Q. L. Baird and A. R. Boynton (Argonne National Lab., Ill.). [1963]. Contract [W-31-109-eng-38]. 5p.

From American Nuclear Society Meeting, New York, Nov. 1963.

The critical U^{235} mass for light-water-moderated, fully-reflected, slightly-enriched, oxide-fuelled cores with H/U^{238} atom ratios of 1 to 5 were determined. Bucklings were obtained and compared with theoretical values. Calculations indicate that the buckling is lowered by about 3% for Al-clad vs unclad fuel. The U^{238}/U^{235} fission ratio was also measured and compared with theory. The disadvantage factor and the epicadmium/subcadmium U^{235} fission ratio were measured by the integral technique. The disadvantage factors disagree with calculations by Pennington. (D.C.W.)

13235 (CONF-187-56) RECENT DEVELOPMENTS IN THE PHYSICS AND SAFETY OF LARGE FAST POWER REACTORS. David Okrent (Argonne National Lab., Ill.). [1963]. Contract [W-31-109-eng-38]. 29p.

From American Nuclear Society Meeting, New York, Nov. 1963.

Some recent cross section measurements and their effect on factor reactor calculations are discussed, together with Doppler and sodium void reactivity effects in large fast power reactors and the conflicts inherent in simultaneous optimization of performance, breeding, and safety characteristics. Hybrid fuel cycles are also considered. (auth)

13236 (EIR-57) TWO-REGION HEAVY WATER–NATURAL URANIUM LATTICE STUDIES IN THE SUBCRITICAL ASSEMBLY MINOR. H. R. Lutz, T. Auerbach, W. Heer, and R. W. Meier (Switzerland. Eidgenössisches Institut für Reaktorforschung, Würenlingen). Aug. 1963. 31p. (CONF-133-38; SM-42/56)

From International Atomic Energy Agency Symposium of Exponential and Critical Experiments with Calculations, Amsterdam, Sept. 1963.

Two-region, natural-uranium, heavy-water lattices were studied in the subcritical assembly MINOR. Starting with a uniform full loading, groups of central elements were successively substituted by another element type. Axial flux plots were taken for each step. The measurements were analyzed by two different methods: the one group

perturbation method proposed by Persson and the two region–two group method. Some of the results are compared with critical substitution experiments performed at Saclay. The merits of doing two region substitution experiments in a subcritical facility are pointed out. (auth)

13237 (GNE/Phys/63-12) ANALYTICAL DERIVATION OF CRITICAL CONDITIONS FROM ONE-GROUP DIFFUSION THEORY FOR THE SPHERICAL GASEOUS-CORE REACTOR (thesis). Gerald T. McCall (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio). May 1963. 99p. (AD-418559)

Critical conditions for the infinite and finite reflected, externally-moderated, gaseous-core, spherical reactor are derived analytically from two-region one-group diffusion theory. The source of thermal neutrons is determined from Fermi age theory. The critical conditions so obtained are quite complicated and difficult to evaluate by hand calculations. They were programmed for the IBM 1620 computer, and critical masses for a pure U^{235}-D_2O reactor were computed for a reasonable range of core radii and moderator-reflector thicknesses. It is shown that for a gaseous-core reactor, two-group diffusion theory gives the identical results as one-group diffusion theory and that the one-group results are in close agreement with multigroup results. The effect of using UF_6 as a gaseous fuel, uniformly mixed in the core cavity with various amounts of H_2 gas, is considered for the finite reactor. (auth)

13238 (NAA-SR-Memo-8607) TRAFIC—A COMPUTER PROGRAM FOR REACTOR TRANSFER FUNCTIONS CALCULATIONS IN THE COMPLEX DOMAIN. W. A. Rhoades and M. A. Boling (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). June 7, 1963. Contract AT-11-1-GEN-8. 65p.

The application of the transfer function method to reactor stability studies is discussed. TRAFIC, a computer program that calculates the plots graphical displays of this data, is described. The details of the derivation of the transfer function for a typical set of differential equations are shown, and the resulting transfer function is solved as a sample problem by TRAFIC. (auth)

13239 A PERTURBATION THEORY FOR THE CONVERSION RATIO AND OTHER NUMERICAL RATIOS OF REACTOR PROCESSES. L. N. Usachev. At. Energ. (USSR), 15: 472-81(Dec. 1963). (In Russian)

Although perturbation theory is used primarily for solving the criticality problems of reactors, it may be employed to estimate the effect of errors and of the possible variations of the size of the core and the reflector on the primary physical constants. Therefore, it was decided to follow the changes of parameters, such as the inequality coefficients, which were calculated originally on the basis of direct spatial and energy distribution measurements. These determinations were carried out without recourse to accurate computations. Using perturbation theory, the desired numerical ratios could be expressed by determining changes in certain parameters, e.g., the macroscopic cross section, the secondary fission neutron spectrum, and the elastically and inelastically scattered neutron spectrum. The same basic numerical computations were used for the determination of the value function that were employed to determine the correlation of the value function with the asymptotic power level. Formulas were derived on the basis of the differences in the parameters of the neutron flux functions in comparison with the processes considered. The algorithm of the changes of the conversion ratio, based on the perturbation theory, involved the determination of the radiative capture of U^{238} and the sum of the radiative capture and fission capture of Pu^{239}. It is possible to determine the conversion ratio separately for the core and the reflector. (TTT)

13240 MULTIPLICATION OF FISSION NEUTRONS IN BERYLLIUM. I. F. Zhezherun, I. P. Sadikov, V. A. Taraban'ko, and A. A. Chernyshov. At. Energ. (USSR), 15: 485-9(Dec. 1963). (In Russian)

In Be-moderated reactors the $Be^9(n,2n)$, $Be^9(n,\alpha)$, and $Be^9(\gamma,n)$ reactions must be taken into account when the neutron balance is determined. Fission neutron multiplication in Be was measured under conditions of spherical geometry by determining the relative increase of the flux from a fission neutron source, surrounded by a spherical Be layer. An increase of the thickness of this layer resulted in an increase of the power level of the source, tending ultimately toward a limiting value which was determined by the slowing down of the neutrons below the threshold of the $Be^9(n,2n)$ reaction. The K_{Be} thus obtained corresponds to the multiplication factor in reactors in which the inelastic scattering process on U nuclei may be neglected, as in the case of the homogeneous thermal reactors using enriched U. The results indicated that if the thickness of the spherical Be layer reaches 12 to 15 g/cm^2, the multiplication factor reaches a maximum value of 1.10 ± 0.015. To a slight extent, this value is also dependent on the prompt γ reaction $Be^9(\gamma,n)$ and the γ radiation due to the short-lived fission products. (TTT)

13241 THE EXISTENCE AND UNIQUENESS OF SOLUTIONS TO SOME NON-LINEAR EQUATIONS IN REACTOR THEORY. O. B. Moskalev and V. A. Chuyanov. Dokl. Akad. Nauk SSSR, 153: 1030-2(Dec. 11, 1963). (In Russian)

Two theorems are presented for determining the existence and uniqueness of solutions of non-linear integral transport equations for monoenergetic neutrsons and isotropic scattering. Such equations arise for instance in the calculation of temperature coefficients of reactivity, or in the determination of the fuel element distribution in a reactor to achieve a desired heat-flux distribution. These equations can be written in the form $A\phi = \gamma\phi$, where A is a non-linear operator which is continuous, monotonic, and satisfies the condition $A(t\phi) \geq tA(\phi)$, where $0 \leq t \leq 1$. Under certain conditions, these equations can be solved by an iterative scheme where $\phi_n = (1/\gamma)A\phi_{n-1}$. (TTT)

13242 SPATIAL DEPENDENCE OF THERMAL NEUTRON SPECTRA IN HEAVY WATER SYSTEMS. Yorio Gotoh, Toshihiro Ichimori, Makoto Obu, and Ken Yamamoto (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi, 5: 979-84(Dec. 1963).

Spatial dependence of thermal neutron spectra in a spherical core-reflector D_2O-system was studied by using Lu^{176}, Mn, and Dy. The sub-cadmium activation ratios of non-$1/v$ to $1/v$ detectors were analyzed instead of thermal activation ratios. A remarkable spatial change of thermal neutron spectrum was observed in a small core system. Good agreement was found between the experiment and the proposed theory with an effective mass, 5.0 amu, of D_2O molecule. The infinite medium spectra also were calculated with the monoatomic gas model of effective mass, 3.6 amu and were compared with experiments. In this case also, good agreement was obtained between the experimental values and the theoretical ones estimated from infinite medium spectra. The slightly heavy effective mass obtained from analysis of the spatial distribution is discussed. (auth)

Design and Feasibility

13243 (NYO-2907-1) QUARTERLY PROGRESS REPORT ON EVALUATION OF AUTOMATIC FLOW BALANCING DEVICE IN BOILING WATER REACTORS, OCTOBER 1, 1963–JANUARY 15, 1964. Report No. 450. R. L. Mela and E. F. Doyle (Dynatech Corp., Cambridge, Mass.). Jan. 23, 1964. Contract AT(30-1)-2907. 14p.

Fabrication and assembly of the high-pressure loop and installation of the test section were completed. The assembled high-pressure loop and test section were hydrostatically pressure and leak tested at 2250 psig. All instrumentation and control equipment was installed and calibrated. The testing program is discussed and a schedule for completion of the program is given. (auth)

13244 NEUTRONIC REACTOR. Stanley L. Koutz, Robert B. Duffield, Robert B. Minogue, Harvey P. Sleeper, Jr., and Melvin Frankel (to General Dynamics Corp.). U. S. Patent 3,120,471. Feb. 4, 1964. Filed July 6, 1959.

A water-cooled and -moderated reactor is described in which a reflector is provided within the water-tight housing around the core. The fuel is Zr–U with 20% enrichment. Natural circulation of coolant from a cooling coil at the top toward the core bottom during operation is achieved. The reactor features freedom from damage from a surge in neutron multiplication. (R.E.U.)

Fuels

Refer also to abstracts 12597 and 12616.

13245 (AGN-TP-66) A 10,000-HOUR TEST OF A NITROGEN- AND AIR-COOLED HIGH-TEMPERATURE FUEL ELEMENT. G. T. Geering, S. Nakazato, and H. T. Watanabe (Aerojet-General Nucleonics, San Ramon, Calif.). [1963]. Contract [AT(10-1)-880]. 29p. (CONF-187-34)

From American Nuclear Society Meeting, New York, Nov. 1963.

An ML-1 prototype fuel element was tested at full power for 10,151 hours in the AGN-GETR Gas-Cooled loop. Reference coolant (99.5 vol % N_2–0.5 vol % O_2) was used during the first 6,415 hours, compressed air during the remainder of the test. After 10,151 hours, the test element was found to be in good condition and no time limit to continued operation was established. Spiral-twisting of fuel pins occurred but did not cause flow restriction or overheating. Maximum oxidation penetration of the Hastelloy-X fuel clad was 0.0044 in., and the clad remained leak tight to the gas coolant. Both the 60 wt % UO_2–BeO and the UO_2 fuel pellets were in operable condition even in the region of maximum burnup (6×10^{20} fissions/cm^3). (auth)

13246 (GEAP-3824) FABRICATION COST ESTIMATE FOR UO_2 AND MIXED PuO_2–UO_2 FUEL. G. D. Collins (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Jan. 24, 1962. Contract AT(04-3)-189. 36p.

A method is given for estimating the fabrication costs for rod-type reactor fuel of UO_2 and PuO_2–UO_2. The cold press and sinter process was selected as the fabrication process, and the method is adaptable to a variety of fuel designs. Fabrication costs are determined for fuel suitable for use in the Fast Ceramic Reactor, and sample calculations are given over a range of diameters and plant throughputs. The reasons for the increased cost of PuO_2–UO_2 relative to UO_2 are discussed. (D.L.C.)

13247 (HW-70178(Rev.)) FLUID MIXING EXPERIMENTS WITH A WIRE-WRAPPED 7-ROD BUNDLE FUEL ASSEMBLY. E. D. Waters (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 1963. Contract AT(45-1)-1350. 38p.

Ions were used as tracers to determine the amount of fluid mixing that occurs between flow subchannels within wire-wrapped 7-rod fuel bundles. Interchannel mixing rates were determined for wire wrap pitches from 4 to 18 in. The experimental interchannel mixing rates were then used in derived equations to predict the coolant temperature difference between flow subchannels when these 7-rod bundles are used under nuclear heat generation conditions. These relations, when combined with pressure drop data published previously, indicate that wire wrap pitches of 10 to 18 in. cause considerable interchannel mixing without excessive pressure drop increase in this configuration of 7-rod bundles. (auth)

13248 (NAA-SR-Memo-8981) EVALUATION OF THE COBRA (OMRE FUEL ELEMENT NO. 237). J. L. Ballif (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 13, 1963. Contract AT-11-1-GEN-8. 34p.

Five individual organic clinkers were found in the coolant channel of each of the seven plates on one side of the COBRA fuel plate. These clinkers had deformed the plates and caused the instrumentation of the COBRA fuel plate to indicate the high temperatures. A mechanism for this failure has been postulated relating the presence of fission products in the reactor cover gas during the early part of the reactor run and the solidified organic material found in the hot cell examination. (auth)

13249 (NAA-SR-Memo-9008) POSTIRRADIATION EVALUATION OF OMRE 6-1 AND OMRE 6-2. W. R. McCurnin (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 4, 1963. Contract AT-11-1-GEN-8. 85p.

Two full-scale prototype fuel elements of the OMRE fourth core design, OMRE 6-1 and 6-2, were fabricated and irradiated in the OMRE third core to test the fourth core design prior to the core loading. Thermocouples indicated a rise in surface temperature on both test elements after 180 Mwd of reactor operation. When the fuel element surface temperature on 6-1 reached the maximum allowable (760°F) the power level of the reactor was decreased to maintain 760°F. The power level was gradually decreased from 5.4 to 4.5 Mw. The test elements were then removed from the core and shipped to CDHC for postirradiation examination. The postirradiation examination revealed massive deposits of carbonaceous material beneath four stainless steel bands used to hold the fuel plates together during assembly. The deposits had completely filled the space between the fuel plates and the box at the center two band locations and caused a distortion in the fuel element box at these locations. These deposits had caused a decrease in flow in the outer channels which had been indicated by the rise in surface temperature. The fuel plates and deposits were subjected to chloroform washing experiments which were not successful in removing or dissolving the hard deposits on the fuel plate surfaces. The fuel plates were examined to determine the fuel growth on both elements, the peak burnup of 6-1, and the integrity of nickel diffusion barrier bond of 6-1. The change in length of the clad fuel plate at the peak burnup location of 2300 Mwd/MTU in 6-1 was 0.49%. The change in length of the other clad fuel plates from 6-1 varied from 0.17 to 0.51%. The change in length of the clad fuel plates

from 6-2 varied from 0.09 to 0.37%. The integrity of the nickel diffusion barrier bond was good with an average consumption of 0.66 mils at the 760°F location. The element was at operating temperature for 1500 hours and the predicted nickel consumption at this temperature would be 0.7 mils. (auth)

13250 (NAA-SR-Memo-9130) POST-IRRADIATION EXAMINATION OF OMRE 7-3 (ELEMENT NO. 235). R. E. Forrester (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 17, 1963. Contract AT-11-1-GEN-8. 15p.

Cermet Driver Element OMRE #235 was disassembled and a limited examination was performed. During the visual examination of the fuel plates, gross deposits were noted on fuel plates #1 and #2 and appeared to have caused some restrictions; however, the flow channels in and around the other fuel plates showed no obstruction. With the exception of fuel plates #1 and #2, no other distortion or other peculiarities were noted. A sample of the gross deposit from plate #1 was obtained for chemical analysis. (auth)

13251 (NAA-SR-Memo-9148) POSTIRRADIATION EXAMINATION OF OMRE DRIVER ELEMENT 7-4 (NO. 236). R. E. Forrester (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 2, 1963. Contract AT-11-1-GEN-8. 14p.

Due to high recorded surface temperature during reactor operations, OMRE Driver Element 7-4 was disassembled and a limited examination was performed in the CDHC facility. Included in the examination were: (1) Visual and photographic inspection of all components such as the fuel element box section and the fuel plates. All the fuel plates appeared in good general condition and were free from damage. All surfaces of the fuel plates were coated with a light black film or had light crusty deposits. No gross deposits or foreign materials were found anywhere on the element. No distortion or peculiarities were noted. Fuel plate photographs and closeup photographs of T/C junctions are shown. (2) Fuel box dimensions were recorded and indicated no significant changes. (auth)

13252 (NAA-SR-Memo-9169) PRELIMINARY EVALUATION OF THERMAL DATA FROM UC TRANSIENT HEATING EXPERIMENTS IN THE TREAT FACILITY. S. J. Stachura and M. Silberberg (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 30, 1963. Contract AT-11-1-GEN-8. 17p.

The thermal behavior of two UC fuel rods is presented for five TREAT transients ranging from 30.7 to 293 Mw-sec. The last burst brought the central fuel temperature to about 4000°F with probable higher edge temperatures and partial UC melting. Comparison of experimental temperature rises with predicted results from analog computer calculations showed very good agreement. The thermal behavior also reflected phase changes and other effects which have been discussed, and which deserve additional examination. No serious pressures were developed during the bursts and in all cases the pressure measured by the variable permeability transducer was well below that corresponding to the peak sodium temperature (i.e., sodium v.p. and helium compression due to heating). (auth)

13253 (NAA-SR-Memo-9184) HEAT TRANSFER ACROSS THE FUEL-CLAD INTERFACE IN SHRINK FIT HYDRIDE-STAINLESS STEEL FUEL ELEMENTS. M. A. Accomazzo and J. Miller (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 8, 1963. Contract [AT(11-1)-Gen-8]. 18p.

A short review of the analytical and experimental background concerning fuel element gap conductance is presented. Application to a U–ZrH_x, shrink-fit stainless steel clad element, operating at heat fluxes near 5×10^5 Btu/hr-ft^2, is considered. A gap conductance on the order of 12,500 Btu/hr-ft^2-°F is found to be appropriate. (auth)

13254 (NAA-SR-Memo-9193) NAA PROGRAM DESCRIPTION. HYREP—HYDROGEN REDISTRIBUTION EQUILIBRIUM PRESSURE. R. F. Berland (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 1963. Contract AT-11-1-GEN-8. 17p.

The program HYREP determines the hydrogen redistribution equilibrium pressure in a fuel element under the assumption that the integrated equilibrium H/ZR is equal to the initial value of H/ZR. The program is written in FORTRAN for the IBM 7090/7094 with FIB II. The data input and method are described. (auth)

13255 (TRG-Report-660) THE CALCULATION OF BURN-UP IN D.M.T.R. EXPERIMENTAL RIGS. T. P. Bishop and C. Hughes (United Kingdom Atomic Energy Authority. Reactor Group, Dounreay, Caithness, Scotland). Oct. 15, 1963. 19p.

The factors that affect burnup are discussed, and modifications to the simple burnup calculation as a product of designed heat rating and irradiation time that give greater accuracy are indicated. Conversion factors between burnup units are included. (D.C.W.)

13256 (WCAP-3717) RENEWED: A PROGRAM FOR NUCLEAR REACTOR FUEL CYCLE ANALYSIS. Reid E. Wolf and John F. Noonan (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Nov. 1962. Contract AT(30-1)-3064. 157p.

The RENEWED program designed for the study of discontinuous out in fuel cycles in large thermal power reactors initially fueled with a uniform loading of U^{235}, U^{238} and the higher nuclides in their irradiation chains is described. A procedure for the analysis of the net fuel cycle cost is included. The program uses modified one-group neutron diffusion theory in r-z geometry, with criticality obtained by a uniform poison search. Fast fissions and epithermal absorptions and fissions are included through a neutron life cycle model. The calculational procedures and input preparation are described. Input and output for a sample problem are included, as well as the FORTRAN listing. (auth)

13257 DISPERSIONS OF OXIDES IN OXIDE MATRICES AS HIGH-TEMPERATURE REACTOR FUELS. J. Williams (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.79-101 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. II." Vienna, International Atomic Energy Agency, 1963.

The potential usefulness of dispersions of PuO_2, UO_2, and ThO_2 in matrices of BeO, Al_2O_3, MgO, and SiO_2 is reviewed in terms of fuel integrity and fabrication. Dimensional stability and fission-product retentivity are the two features most important to fuel integrity. Compatibility of the constituents of the fuels with one another and with the coolant will influence dimensional stability, but oxide fuels are well favored in these respects. Dimensional changes under irradiation will contain contributions from neutron and fission fragment damage to the matrix, from radiation damage to the fissile-fertile phase, and from agglomerated fission-product gases. Thermal stresses are also capable of effecting changes in shape. However, information on mechanisms for stress relaxation is too limited to enable any reasonable theoretical assessment of behavior to be

made. Both light irradiation and high burn-up studies of fission-product release from the fissile-fertile oxides have concerned themselves mainly with the gaseous products, chiefly xenon. Data on the release of other fission products is very limited as is also information on the movement of fission products in general through the potential matrix materials. Studies of the permeability of sintered pure oxides indicate that densities of at least 95% theoretical density (maybe even 98%) will be needed to eliminate open porosity in such matrices. A variety of techniques are available for the preparation of fissile-fertile particles, for their coating, and for their incorporation into high-density matrices. Work on laboratory-scale fabrication processes is well advanced. (auth)

13258 DEVELOPMENT OF UO_2–STAINLESS STEEL FUEL PLATES CONTAINING 30-50 VOL. % OXIDE. H. Lloyd (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.103-42 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. II." Vienna, International Atomic Energy Agency, 1963.

A description is given of developments associated with the fabrication of UO_2–stainless steel plate type fuel elements containing up to 50 vol % UO_2. The preparation of high-density spherical UO_2 sintered particles in the 100- to 500-μm size range and the compacting and sintering of cermet plate cores with the particles uniformly distributed in the stainless steel matrix are described together with procedures for hot roll-bonding the fuel plates. Rolling at temperatures up to 1300°C using total deformations in the 40 to 90% range were studied to establish optimum conditions for the production of high-density cores and to achieve good bonding between the plate components with minimum fragmentation and stringering of the UO_2 particles. The manufacture of large fuel plates utilizing multi-core plates which are bonded together during hot rolling is also described. Data are presented on the mechanical properties of 30, 40, and 50 vol % UO_2–stainless steel cermets, prepared as described above, and tested in the "as rolled" and annealed condition at various temperatures up to 700°C, using specimens taken laterally and longitudinally to the direction of rolling. The influence of size and uniformity of distribution of the UO_2 spheres on consistency of mechanical properties are discussed. The strength of bonding between core and cladding for similar cermets in the same temperature range was also assessed. Results are also included of thermal cycling tests between 50 and 800°C, which was done to study the effects on bond stability and cermet structure after 100, 500, and 1000 cycles. (auth)

13259 FABRICATION AND TESTING OF PROTOTYPE APM-CLAD UO_2 FUEL ELEMENTS. J. L. Ballif, III, W. H. Friske, and R. B. Gordon (Atomics International, Canoga Park, Calif.). p.235-61 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. II." Vienna, International Atomic Energy Agency, 1963.

In support of the 50-Mw(e) Prototype Organic Power Reactor Program (POPR), extensive development work has been performed on aluminium powder metallurgy (APM) products, toward their use as cladding for UO_2 fuel. As part of this development work, eutectic bonding, flash butt welding, and cold-pressure welding were investigated as methods for making end closures in the fuel element cladding. Vibratory packing was studied as a means of filling APM tubes with UO_2. Out-of-pile tests were conducted to obtain information on APM-UO_2 compatibility. This work revealed that, under present conditions, eutectic bonding was the most suitable method for making end closures; vibratory packing produced fuel densities in the range of 80 to 88% of theoretical density; and no APM-UO_2 reaction took place in the range of POPR operating temperatures (850°F maximum fuel-cladding interface temperature). As a result of this development work, five APM-clad UO_2 prototype fuel elements have been fabricated for testing in the Organic Moderated Reactor Experiment (OMRE). Each element consisted of 24 or 25 APM-clad fuel rods, arranged in a 5 × 5 array in a nickel-plated steel or an APM fuel box. To increase surface area, the extruded APM cladding had eight fins which were spiralled to a pitch of 45 or 90°/ft to further improve heat transfer. The fuel rod end closures were made by eutectic bonding of silver-plated aluminium end plugs to the APM tubing. The elements were instrumented to: measure cladding surface and coolant temperatures, detect fuel rod failure, change coolant velocity (means of achieving peak cladding surface temperature of 850°F), measure coolant velocity, and measure fission gas build-up. These elements have been installed in the OMRE with target fuel burn-ups of 25,000 to 30,000 Mwd/t of uranium. As of 1 April 1963, they had achieved accumulated burn-ups ranging from 7700 to 12000 Mwd/t of uranium. Two of the elements had been removed from the reactor as a result of problems encountered with instrumentation associated with their tests. The other three elements were still in the reactor. The results of the experimental work to date give every indication that the APM-UO_2 fuel system will achieve the goals set for the POPR program. (auth)

13260 DESIGN OF THE SMALL RODS FORMING THE FUEL ELEMENT OF THE FIRST CHARGE OF THE EL4 REACTOR-CLADDING PROBLEMS. H. Bailly, C. Ringot, and M. Weisz (Centre d'Etudes Nucleaires, Saclay, France). p.275-301 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. II." Vienna, International Atomic Energy Agency, 1963. (In French)

The fuel element for the first charge of EL4 makes use of stainless steel cans. The grade of steel chosen and the can thickness depend on the corrosion resistance and mechanical strength required. The operating stresses and temperatures are such that fabrication of a can lasting throughout the life of the fuel element calls for a highly resistant grade of steel, of thickness greater than 0.5 mm. When the can bears on the fuel as a result of creep, deformation in diametrical clearance may lead to ovalization and folding, while deformation in longitudinal clearance may cause buckling of the can. Numerous tests have been carried out on cans of thickness 0.3 and 0.4 mm to determine type of deformation as a function of clearance. To be certain of avoiding ovalization with the thicknesses proposed and to keep the internal temperature of the fuel as low as possible, the clearance must be reduced to zero in fabrication. (auth)

13261 POSSIBILITY OF USING NUCLEAR FUELS COMPOSED OF A THORIA NUCLEUS AND A URANIUM OXIDE RING. J. Doumerc and R. Hauser (Compagnie pour l'Etude et la Realisation de Combustibles Atomiques, Bonneuil-sur-Marine, France). p.339-46 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. II." Vienna, International Atomic Energy Agency, 1963. (In French)

A study was made to investigate the power gains that might be expected by concentrating the fissionable material, the source of the heat, at the periphery of the fuel. The fertile material forming the central part plays only a minor role in the production of power, and only at the end; it also can tolerate slightly higher maximum temperatures than can the fissionable material. By comparison with a pure UO_2 fuel taken as reference, a composite arrangement

would appear to offer the following advantages in certain configurations: (1) A specific power gain of from ten to several dozen per cent; and (2) for the same initial reactivity, greater longevity in the reactor because of the presence of two separate fertile materials. A final graphic analysis is used to identify the best compromise between the various parameters involved: dimensions of the thoria and uranium dioxide, uranium-235 enrichment, temperature profile within the composite pellet, and fuel-cooling arrangements. Parallel to theoretical research, technological studies were conducted to devise a method for fabrication of the pellets and to investigate their properties. (auth)

13262 DEVELOPMENT OF NON-METALLIC FUEL ELEMENTS FOR A HIGH-TEMPERATURE GAS-COOLED REACTOR. B. Liebmann, L. Schaefer, and G. Spener (Nuklear-Chemie und -Metallurgie GmbH, Wolfgang, Ger.). p.415-26 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. II." Vienna, International Atomic Energy Agency, 1963.

In connection with fuel element development work for the high-temperature gas-cooled reactor of the Brown-Boveri/Krupp Reaktorbau G.m.b.H., two different fuel element concepts were considered and developed. In both cases the fuel element consists of a graphite ball of 6 cm in dia which contains the fuel insert, a cylindrical pellet of about 20 mm in dia and 16 mm in height. The two concepts differ in the type of the fuel insert as well as in the preparation of the graphite ball. In the first concept, the fuel insert consists of a mixture of UC_2 and graphite which is prepared by blending U_3O_8 and graphite, pressing them into pellets, and reacting the two components in a vacuum furnace at 1800°C. The atomic ratio of U:C is 1:45. Since this type of fuel pellet does not retain the fission products completely, the surrounding graphite sphere had to be made impervious to fission products by impregnation in order to obtain a fission-product retaining element. Permeabilities of the order of 10^{-4} cm^2/sec could be achieved. In the second concept, the fuel insert consists of a solid solution of UC in ZrC and is coated with a layer of ZrC. The molar ratio of UC to ZrC is 1:20. The fuel pellet preparation was accomplished by the following procedure: UO_2, ZrO_2, and graphite were mixed and pressed into pellets. The pellets were reacted to the carbides. Ball milling of the carbides was followed by hot pressing at temperatures of 2000°C. Densities of more than 95% of the theoretical density could be achieved. A full description of the preparation and of some physical properties of the fuel pellets is given. A sufficient fission gas retention behavior of this type of fuel insert which allows it to be put into unimpregnated graphite balls is expected. Other advantages of this kind of fuel are discussed. (auth)

13263 THE APPLICATION OF NON-METALLIC CORE MATERIALS IN A HIGH-TEMPERATURE REACTOR EXPERIMENT. R. A. U. Huddle and L. R. Shepherd (Atomic Energy Establishment, Winfrith, Dorset, Eng.). p.467-95 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. II." Vienna, International Atomic Energy Agency, 1963.

The OECD High-Temperature Reactor Project (DRAGON) was set up to develop the technology of high-temperature gas-cooled reactors and, as part of this development, to construct and operate a 20-Mw(t) reactor experiment. The reactor, which is now nearing completion, is a helium-cooled system with a core-outlet temperature of 750°C; it employs U^{235} fuel with thorium as a fertile material. A particular feature of this system is the absence of any metals in the core. Because of the high temperatures involved, namely, up to 1050°C at fuel element surfaces and above, 1500°C in the hottest regions of the fuel, refractory nonmetallic materials are employed. All the core material is incorporated within the fuel element which leads to a high ratio of heat transfer surface area to core volume and hence permits a high average power density leading to a relatively compact system. Each fuel element consists of a cluster of graphite tubes, containing the fissile and fertile materials as carbides incorporated in graphite pellets. A purge flow of the helium coolant passing through the center of each fuel rod is extracted from the base whence it passes into a helium processing plant to remove fission products and other impurities before being returned to the reactor. This procedure reduces the escape of fission products from the very hot ceramic fuel into the primary coolant stream. Problems associated with the development and production of ceramic fuel bodies and graphite for this reactor, and the behavior of these materials under operating conditions are outlined. Some experience from irradiation and in-pile loop investigations are reported. The main emphasis in this program is on the development of the high-temperature gas-cooled reactor for application as an economic power-producing system. (auth)

13264 EFFICIENCY OF DIFFUSION BARRIERS FOR ALUMINIUM-CANNED URANIUM FUEL ELEMENTS. F. Brossa, H. W. Schleicher, and R. Theisen (Centre Commun de Recherche Nucléaire d'Euratom, Ispra, Italy). p.511-34 of "New Nuclear Materials Including Non-Metallic Fuels. Vol. II." Vienna, International Atomic Energy Agency, 1963.

The use of aluminium-canned metallic uranium fuel elements is limited to relatively low temperatures if no special means are provided to inhibit the intermetallic diffusion between fuel and can. Intermediate layers should be efficient diffusion barriers but should, at the same time, effect a good bonding and exhibit a good thermal conductivity. This restricts these barriers practically to metallic layers. In the frame of the Orgel project, different barriers have been studied. Deposition methods have been developed and the diffusion behavior of the respective couples and triplets has been evaluated by metallographic, micro-hardness, and electron microprobe analyses. Ni, Cr, V, Nb, and multiple barriers such as Si–V and Si–Cr seem up to now to show the greatest promise for practical applications. The results obtained thus far are described and the different barriers are compared with respect to deposition procedures, diffusion rates, formation of intermetallic compounds, and uranium concentration gradients. On the basis of these phenomena, the thickness of the diffusion barrier needed under specific reactor conditions (pressure, temperature and lifetime of fuel element) can be determined. (auth)

13265 CALIBRATION OF SURFACE-ATTACHED THERMOCOUPLES ON A FLAT PLATE FUEL ELEMENT BY ELECTRICAL ANALOGUE AND ANALYTICAL TECHNIQUES. J. H. Brindley (Atomics International, Canoga Park, Calif.). 11p. (CONF-187-65)

From American Nuclear Society Meeting, New York, Nov. 1963.

A scaled-up electrical analog model of a surface-attached thermocouple exposed to an organic coolant stream was constructed to determine the effects of coolant velocity, coolant temperature, and fouling film formation on the magnitude of the thermal loading errors associated with the thermocouple assembly. The analog model was constructed from stainless steel sheet utilizing the principle that the

relative differences in the thermal conductivity of the SS–UO_2 fuel, the SS fuel cladding, and the chromel–alumel thermocouple can be simulated by appropriate thicknesses of the stainless steel sheet joined by closely spaced spot welds. (R.E.U.)

13266 AN ASSAYING SYSTEM FOR HTGR FUEL COMPACTS. Kenneth A. Zimmermann (General Atomic Div., General Dynamics Corp., San Diego, Calif.). 12p. (CONF-363-15; GA-4688)

From International Symposium on Plasma Phenomena, San Diego, Calif., Oct. 1963.

An automatic gamma-ray scanning apparatus to determine U^{235} content in fuel compacts is described. Two automatic scanners, controlled by a logic unit, drive each compact past a NaI(Tl) scintillation detector. Pulse-height selection permits counting of only the 184-kev gamma rays emitted. After each scan, a scaler containing the total count is gated off and a readout cycle is initiated. Comparison logic analyzes the count in terms of four values set into the system by selector switches. The interrogation circuits then decide the percentage of fuel loading relative to that of a standard element and indicate this to the operator. Simultaneously, the scaler count is printed on paper tape. Possible errors are considered and these are correlated with test results. (auth)

13267 IMPROVEMENTS IN FUEL ELEMENTS FOR NUCLEAR REACTORS. Richard Antony Skinner (to Nuclear Power Plant Co. Ltd. and John Thompson Nuclear Energy Co. Ltd.). British Patent 947,715. Jan. 29, 1964. Filed Aug. 26, 1960.

The design of a reactor fuel element with a device to ensure prompt detection of leaks is patented. The fuel element is the type in which an oxidizable fuel such as U is enclosed in a container. A material that is more readily oxidizable than the fuel is included in the container. If coolant leaks into the container, the material expands and makes a leak large enough for escaping fission products to produce a signal on the leak-detection equipment. In this way leaks can be detected before damaging amounts of UO_2 are formed. Zr alloyed with small amounts of Ti or Al is recommended for the readily oxidizable material, and it should be located between the fuel and one or both ends of the container. (M.P.G.)

13268 IMPROVEMENTS IN FUEL ELEMENTS FOR NUCLEAR REACTORS. (to General Dynamics Corp.). British Patent 948,313. Jan. 29, 1964. Priority date July 31, 1961, United States.

The design of a fuel element for high-temperature gas-cooled reactors, which provides high power density and very efficient heat transfer from fuel element to coolant, is patented. The nuclear fuel is enclosed in a container of neutron-moderator material having a low permeability to fission products. Purge-gas inlets and outlets to the interior of the container are located at the upper and lower ends of the container. A fission-product trap, which can be inserted and removed from the container, is located within the container below the fuel. The fuel consists of stacked annular or split-ring fuel compacts with aligned grooves at the edges to provide purge-gas passageways. The purge gas passes from the inlet, down along the fuel, through the trap, and to the outlet. The fission-product trap consists of radial cavities aligned with the passageways in the fuel and containing particulate carbon coated with an electropositive material. The fuel elements are easily assembled, disassembled, and aligned in the reactor core. (M.P.G.)

13269 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. John Brian Sayers (to United Kingdom Atomic Energy Authority). British Patent 948,479. Feb. 5, 1964. Filed Nov. 3, 1961.

A reactor fuel element is designed for high-temperature reactors. The fuel element comprises a ring of enriched nonmetallic fissile material supported at its inner periphery by depleted nonmetallic fissile material and enclosed in a sheath. An example of such a fuel element is described in which the fissile material in both the ring and support is UO_2, and the sheath is stainless steel. (D.L.C.)

13270 IMPROVEMENTS IN FUEL ELEMENTS FOR NUCLEAR REACTORS. Richard Anthony Skinner (to Nuclear Power Plant Co. Ltd. and A.E.I-John Thompson Nuclear Energy Co. Ltd.). British Patent 949,103. Feb. 12, 1964. Filed Oct. 30, 1961.

An extension is made to a previous British patent 947,715 (Aug. 26, 1960), in which a fuel element is described that is made of an oxidizable fuel in a closed container along with material that is more readily oxidized and which expands rapidly when coolant leakage into the container occurs. This provides a detectable leak before the fuel itself is oxidized. A piercing member is provided adjacent to the more readily oxidizable material and upon expansion pierces the container thus indicating coolant leakage. (R.E.U.)

13271 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS AND TO FUEL ELEMENTS THEREFOR. Shirley Russell Hopkins and Alan Charles Anthony Saunders (to United Kingdom Atomic Energy Authority). British Patent 949,236. Feb. 12, 1964. Filed July 4, 1961.

It is proposed for assembling or subsequently servicing, a nuclear reactor core that superposed fuel elements introduced as a unit into the core are rendered dischargeable individually. Therefore a string of elongate nuclear fuel elements were superposed one on another to form a column and provided with means whereby the string can be lifted and lowered as a unit, with the lowest element suspended from the means and the other elements supported serially on it. The means is removable from the elements by an operation remote from them. In its simplest form the suspension means is a freely flexible cable. (M.C.G.)

13272 FUEL ELEMENT FOR A GAS-COOLED, GRAPHITE-MODERATED NUCLEAR REACTOR. Hartwig Benzler and Roland Kuehnel (to Deutsche Babcock and Wilcox-Dampfkesselwerke AG). German Patent 1,156,901. Nov. 7, 1963. Filed July 3, 1957.

The fuel element described consists of an arbitrarily preformed moderator nucleus which is provided with a can of one or more layers. The fissionable material is located between two or more layers and/or within the layers of the can. The moderator nucleus can have perforations into which fissionable or breeder material is inserted. (Gmelin Inst.)

13273 NUCLEAR FUEL ELEMENT. Hugo Heinrich Ludolf Ritz (to C. C. Parsons and Co. Ltd.). German Patent 1,159,572. Dec. 19, 1963. Priority date Jan. 10, 1958, Great Britain.

The fuel element is composed of a pluraility of sheathed fuel rods that are located within a container through which a coolant medium is circulated. The fuel rods are inclined relative to the axis of the container and are arrayed in successive rows. The fuel rods of successive rows are

inclined in opposite directions so that the rods of the 1, 3, 5, etc., and of the 2, 4, etc., rows respectively are parallel to each other. (Gmelin Inst.)

13274 FUEL ELEMENT. Walter P. Wallace and Massoud T. Simnad (to General Dynamics Corp.). U. S. Patent 3,119,747. Jan. 28, 1964. Filed June 8, 1960.

A fuel element is described with provisions for reduction of the tendency of the container to irreversibly elongate during thermal cycling of the fuel body inside. An inwardly tapered fuel body gap is provided within the container for a lubricant of colloidal graphite. (R.E.U.)

13275 DEVICE FOR PRODUCTION OF NUCLEAR ENERGY FROM U^{233}. Glenn T. Seaborg, John W. Gofman, and Raymond W. Stoughton (to U. S. Atomic Energy Commission). U. S. Patent 3,123,535. Mar. 3, 1964.

A system for the production of nuclear energy comprising U^{233} distributed in a neutron-moderating material is described. The moderator is of $Z < 16$ and has a capture cross section less than one barn. The uranium is so distributed and is in such a mass as to provide for neutron thermalization internally. A chain reaction is thus achieved. (R.E.U.)

Power and Power-Breeder Reactors

13276 (ACNP-63625) REACTOR VESSEL TOP NOZZLE CLOSURE. 350 PSIG DESIGN—SILASTIC O-RING GASKET. D. A. Lampe (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Oct. 25, 1963. Contract [AT(10-1)-925]. 22p. (EGCR-STUDY-II-469-1)

A stress analysis was made of the EGCR reactor vessel top nozzle closure with a silastic "O" ring. The calculations indicate that the closure is adequately designed for a working pressure of 350 psig at 200°F. (D.L.C.)

13277 (AECL-1882) CANADIAN DEVELOPMENTS IN NUCLEAR POWER. J. L. Gray (Atomic Energy of Canada Ltd., Chalk River, Ont.). Feb. 1, 1964. 25p.

A discussion is presented of the Canadian nuclear power program, the reasons for the development of heavy water reactors in Canada, and the future prospects for Canadian nuclear power. The historical background of the program is described briefly. The demonstration runs of NPD and the status of Douglas Point Power Station are described. The design of 500-Mw CANDU and other advanced heavy water power reactors is considered. (D.L.C.)

13278 (AGN-TM-405) ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM. ML-1 PRESSURE VESSEL REPAIR SUMMARY REPORT. (Aerojet-General Nucleonics, San Ramon, Calif.). Dec. 1963. Contract AT(10-1)-880. 66p.

Evidence of a leak between the coolant gas area and the moderator area of the ML-1 reactor was observed in March 1963. The pressure vessel was removed from the reactor skid and the source of the leak identified and repaired. The reactor skid was reassembled, with certain modifications, and was available for continued operation in mid-September 1963. (auth)

13279 (ANL-6773) ANALYTICAL STUDY OF THE TRANSFER FUNCTION OF EBR-I MARK IV. Jiro Wakabayashi (Argonne National Lab., Idaho Falls, Idaho). Sept. 1963. Contract W-31-109-eng-38. 58p.

A numerical analysis was performed for the EBR-I Mark IV. The analytical results for the transfer function are in good agreement with experimental results. (D.C.W.)

13280 (CEA-2325) CALCUL DES IMMOBILISATIONS FINANCIERES DES CYCLES DE COMBUSTIBLE. (Calculation of the Working Capital Invested in Fuel Cycles and its Interest Charges). J. Gaussens (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 53p.

In French and English.

All the processes undergone by the nuclear material, including the various steps of fuel element manufacturing and of irradiated fuel reprocessing lead to working capital investments varying with the type of reactor, that must be taken into account in the kwh cost calculation. A calculation method called: "present worth method" is described and some examples given concerning reactors the main fuel of which being either natural uranium or enriched uranium or plutonium. The importance of these investments in the case of fast breeder reactors is pointed out. (auth)

13281 (CONF-187-37) ADVANCED DESIGNS AND SPECIAL APPLICATIONS FOR FAST BREEDERS. R. Philip Hammond (Oak Ridge National Lab., Tenn.). Nov. 11, 1963. Contract [W-7405-eng-26]. 23p.

From American Nuclear Society Meeting, New York, Nov. 1963.

Some advanced concepts for fast breeder reactors are described and discussed in terms of their economic potential. (D.C.W.)

13282 (CONF-187-74) NUCLEAR ANALYSIS OF PM LONG-LIFE CORE 3. Raymond Bagley and Critz George (Martin-Marietta Corp. Aerospace Div., Baltimore). [nd]. Contract [AT(30-1)-2345]. 15p.

From American Nuclear Society Meeting, New York, Nov. 1963.

A parametric or concept study was made to define the performance profile over a range of configurations for Core 3. The results indicate that a lifetime of 100 Mw-yr can be obtained from a 7 ft^3 pressurized water core. If used as a 10-Mw heat source, the core has a lifetime approaching that of plant equipment, 90,000 full-power hours. Core 3 is also suitable for operation at 40-Mw thermal power. (D.L.C.)

13283 (DLCS-5001263) MONTHLY OPERATING REPORT, DECEMBER 1963. (Duquesne Light Co., Shippingport, Penna.). Contract AT(11-1)-292. 48p.

The station operated at a reduced electrical output for the radial flux tilt test. Reference water conditions were within specifications in the RCS, reactor plant auxiliary systems, and boilers. The RWDS cooling water was out of specifications for a short period, however, reference conditions were re-established and maintained during the remainder of the month. Conditions related to personnel radiation exposures and radioactive contamination were normal. The status of refueling procedure preparation, pre-assembly of Core 2 components, training, and work performed to date are presented. Construction work on the HDS modification continued. Portions of the Decontamination System were tested. (auth)

13284 (HW-77907) DESIGN CRITERIA — PRTR DECONTAMINATION AND D_2O CLEANUP FACILITIES. F. H. Shadel and P. C. Walkup (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 13, 1963. Contract [AT(45-1)-1350]. 30p.

Detailed design descriptions are given of the building and equipment for preparing decontamination solutions for the PRTR reactor piping systems and its auxiliaries, and of the equipment for the D_2O cleanup system of PRTR. (D.L.C.)

13285 (HW-78492) D_2O LOSSES AT THE PRTR. R. G. Clark (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 1, 1963. Contract AT(45-1)-1350. 12p.

The heavy water usage during all phases of reactor operations from Jan. through Sept. 1963 are discussed. The main avenues and sources of the heavy water loss are described. Heavy water losses have been averaging 30 lb/day during sustained operating periods, as compared to 60 lb/day a year ago. The efficiency of the heavy water recovery system was also improved in that the recovered heavy water were less degraded. Other heavy water expenses and helium losses are discussed. (D.L.C.)

13286 (HW-79669) MODERATOR LEVEL CONTROL IN THE PLUTONIUM RECYCLE TEST REACTOR. J. F. Fletcher and R. I. Smith (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 1963. Contract AT(45-1)-1350. 37p.

The Plutonium Recycle Test Reactor features reactor control through control of the level of the heavy water moderator. Use of a gas balance principle enables precise control of moderator level and rapid dumping of the moderator from the reactor for emergency shutdown. Development of the moderator level control system entailed an extensive program of testing using a full-scale mockup of the reactor calandria to establish the system characteristics. Experience obtained with the control system during development, reactor startup, and the early phases of reactor operation is described as well as the system itself. The moderator level control system has considerably exceeded design requirements for reactor control as well as for emergency shutdown. (auth)

13287 (IDO-28617) ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM. Quarterly Progress Report, July 1-September 30, 1963. (Aerojet-General Nucleonics, San Ramon, Calif.). Nov. 15, 1963. Contract AT(10-1)-880. 61p.

The ML-1 power plant was not operated. The repair of the leak in the pressure vessel and modification and reassembly of the reactor were completed. The design of turbine blades for the CSN-1 was revised. The unit was reassembled with spare parts to permit the conduct of a bearing evaluation program. This program was interrupted shortly after inception by an explosion in the turbine end of the unit. The damage was confined to parts scheduled for modification in the CSN-1A rebuild. The TCS-670A turbine compressor set performed satisfactorily during open cycle test and was installed on the power conversion skid for closed cycle tests. Early in this test program, the unit seized when the turbine interstage seal failed. The disassembly and inspection of the unit was completed. Testing of the mock-up of the ML-1 pressure vessel was interrupted after 2938 hours of operation by the failure of the bearings in the moderator circulating pump. A hot cell examination of the IB-17R-1 (instrumented ML-1-II prototype test element) was initiated. No unanticipated conditions were observed. Irradiation of the IB-17R-2 and -3 test elements in the GETR loop continued without incident. (auth)

13288 (NAA-SR-Memo-9046) PRELIMINARY EVALUATION OF THE EXAMINATION OF OMRE 9-1. L. Goodman (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Sept. 26, 1963. Contract AT-11-1-GEN-8. 36p.

The post-irradiation examination of OMRE 9-1 produced, in part, the following results: (1) The thermally estimated peak burnup was 6070 Mwd/MTU and the elemental average was 2150 Mwd/MTU. (2) The maximum dimensional change of the fuel was 3.8%. (3) Fouling was a minor problem because of extra clean coolant in the reactor and/or improved fuel element design. (4) There were no indications of mechanical instability. (5) The nickel diffusion-barrier remained intact throughout, in the regions examined. The conclusion drawn from these results is that U–3.5 Mo with aluminum cladding can make a satisfactory fuel element under the proper design and operating conditions. (auth)

13289 (NAA-SR-Memo-9244) 1000 MWE SGR PARAMETER STUDY—CORE THERMAL AND HYDRAULIC ANALYSIS. J. K. Imig (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 19, 1963. Contract [AT(11-1)-Gen-8]. 32p.

Parametric heat transfer studies were performed for a 1000-Mwe SGR core to assist in determining an optimum power plant design. The parameters that affect heat transfer and were studied are maximum fuel centerline temperature, diameter of fuel rods, number of fuel rods per element, and coolant velocity. A total of 30 cases were studied. Nine fuel element geometries were studied consisting of 3 types of fuel rod clusters (12, 18, and 30 rods per cluster) with 3 rod diameters for each type of cluster. In 27 of the 30 cases the velocity was adjusted to give a constant core pressure drop ($\Delta p = 17.8$ psi) and each of the 9 geometries was studied with 3 maximum fuel centerline temperatures. In 3 of the cases the effect of variable pressure drop was studied for one geometry with the same maximum fuel centerline temperature. In addition to the heat transfer studies a new heat transfer code, SORTD II, is described. This code will adjust the input process tube diameter to obtain a specified maximum fuel centerline temperature. (auth)

13290 (ORNL-TM-787) SOME NOTES ON MIXED OWNERSHIP OF DUAL-PURPOSE POWER-DESALINATION PLANTS. I. Spiewak (Oak Ridge National Lab., Tenn.). Oct. 14, 1963. Contract [W-7405-eng-26]. 13p.

Estimates of the cost of dual-output nuclear desalination plants are presented, based on projected costs of boiling H_2O cooled heavy water reactors and multistage flash evaporators. Several combinations of private and public ownership of the facilities are shown. Plants in the size range 1050 to 25,000 Mw thermal are considered. (auth)

13291 (PRDC-TR-75) MONTHLY TECHNICAL REPORT [ON APDA ACTIVITIES], SEPTEMBER 1963. (Power Reactor Development Co., Detroit). Contract AT(11-1)-476. 12p.

Progress is reported on the development and operation of the Fermi Fast Breeder Reactor. Information is included on sodium purity, graphite and purity control of primary shield tank atmosphere, sodium-hydrogen system, sodium-carbon program, shielding, nuclear test program, computer programs, component systems, electrical and mechanical instrumentation, and test operations. (N.W.R.)

13292 (SRO-98) HEAVY WATER POWER REACTOR PROGRAM MONTHLY PROGRESS REPORT, JANUARY 1964. (Savannah River Operations Office, AEC). 9p.

Research and development progress is reported for the AEC-AECL cooperative program CANDU, for SAP, for non-destructive testing of fuel sheath tubing, fluid dynamics and heat transfer, zirconium technology, irradiation programs, D_2O technology, and oxide fuels at the Savannah River Plant. Operations of HWCTR and Carolinas-Virginia Tube Reactor are reported. (R.E.U.)

13293 (TID-20131) DEVELOPMENT OF THE EGCR STEAM-GENERATOR MODEL. Ralph P. Marcotte (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington,

D. C.). July 20, 1960. Contract [AT(10-1)-925]. 125p. (EGCR-STUDY-II-650-1)

Analog computer models were developed to represent the dynamic response of the EGCR steam generator to reactor-plant and/or steam-plant disturbances. The simplified model was found to represent adequately the dynamic behavior. The detailed model accounts for steam-drum and natural-circulation effects. (D.L.C.)

13294 (TID-20141) GARIGLIANO NUCLEAR POWER PLANT FINANCIAL REPORT, SEPTEMBER 30, 1963. (Società Elettronucleare Nazionale, Rome). 4p.

A financial report up to September 30, 1963, is presented and it includes cost estimates and expenditures. (N.W.R.)

13295 (TID-20143) GARIGLIANO NUCLEAR POWER PLANT. Cost Estimate and Expenditures. Financial Report, March 31, 1963. (Società Elettronucleare Nazionale, Rome). 4p.

A financial report up to March 31, 1963, is presented and it includes cost estimates and expenditures. (N.W.R.)

13296 (TID-20146) MODIFICATION OF THE CONTROL ROD DRIVE MECHANISMS FOR THE GARIGLIANO NUCLEAR POWER PLANT. (Società Elettronucleare Nazionale, Rome). [nd]. 10p.

During prestartup tests on the control rod drives, abnormal behavior occurred in several drives owing to the presence of metal chips and other foreign material in the hydraulic system selector valves and drives. Since the plant was shut down for repair of the main generator, it was decided to modify the drives and hydraulic system to increase their protection against entry of foreign material. The modifications are described. (D.L.C.)

13297 (TID-20177) GARIGLIANO NUCLEAR POWER PLANT. Second Quarterly Progress Report, 1963. Technical Report, June 30, 1963. (Società Elettronucleare Nazionale, Rome). 47p.

Progress made in the development and construction of the Garigliano Nuclear Power Plant is summarized. Information is included on the plan and profile of the plant, construction schedule, and comparison of scheduled and actual progress. A list is included on instruction books. (N.W.R.)

13298 (TID-20178) GARIGLIANO NUCLEAR POWER PLANT. First Quarterly Progress Report, 1963. Technical Report, March 31, 1963. (Società Elettronucleare Nazionale, Rome). 86p.

Progress made in the development and construction of the Garigliano Nuclear Power Plant is summarized. Information is included on the plan and profile of the plant, construction schedule, and comparison of scheduled and actual progress. Three lists are included on technical specifications, APED design drawings, and instruction books. (N.W.R.)

13299 (TID-20179) GARIGLIANO NUCLEAR POWER PLANT. Third Quarterly Progress Report, 1963. Technical Report, September 30, 1963. (Società Elettronucleare Nazionale, Rome). 8p.

Progress made in the development and construction of the Garigliano Nuclear Power Plant is summarized. Information is included on power testing, reactor fuel loading, control rod drive system, and maintenance. (N.W.R.)

13300 (TID-20180) GARIGLIANO NUCLEAR POWER PLANT. Fourth Quarterly Progress Report, 1963. Technical Report, December 31, 1963. (Società Elettronucleare Nazionale, Rome). 8p.

Progress made in the development and testing of the Garigliano Nuclear Power Plant is summarized. (N.W.R.)

13301 (WCAP-3724) LOAD-VARIATION RESTRICTIONS IN A CHEMICALLY POISONED LARGE PWR CORE. H. Aisu, R. F. Barry, and P. G. Lacey (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Mar. 1963. Contract AT(30-1)-3064. 73p.

The results are presented of an analytic study of load variation restrictions to base load operation of a large pressurized water reactor core controlled by chemical shim and a movable low worth control rod group partially inserted to handle reactivity transients other than fuel burnup and xenon. Nuclear axial hot channel factors and differential control rod worths were calculated at different banked positions for group worths of 1, 2, 3, and 4% $\Delta k/k$. The results obtained for hot full power operation are compared with those obtained for very low power operation. The effects of rapid bank motion are compared with very slow motion. Also, the effects of non-uniform Doppler and xenon are evaluated separately. (auth)

13302 (WCAP-1831) PRIMARY SYSTEM PRESSURE RESPONSE STUDY DUE TO POWER UNBALANCE (TOPS CODE). Amir N. Nahavandi and George B. Killinger (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Sept. 1961. Contract AT(30-1)-3064. 309p.

A detailed thermodynamic transient analysis of the primary system of the pressurized-water nuclear power plant is presented. A digital computer code for an IBM-7090, designated as TOPS was prepared that solves numerically the governing differential and algebraic equations by an iterative scheme using a finite difference technique. This code can determine the thermal and hydraulic behavior of the primary system during the transient operation due to a given power unbalance. The system mass flow rate, enthalpy, pressure, and other important system properties are calculated as functions of space and time. To assist the designer in the application of this code, a sample problem for a typical nuclear power plant was worked out. (auth)

13303 (AEC-tr-6336) CONTRIBUTION TO THE STUDY OF THE $U^{233}-Th^{232}$ CYCLE IN FAST REACTORS. P. Clauzon, A. Kania, and P. Pomie. Translated for Oak Ridge National Lab., Tenn., from paper presented at the "Expanded Colloquium of the European Society of Atomic Energy Fuel Cycles for Power Reactors, Baden-Baden, September 9-14, 1963." 23p.

The behavior and characteristics of fast breeder reactors (1000 Mw) using the $U^{233}-Th^{232}$ fuel cycle were calculated. The results are used in a comparison of the economics of the $U^{233}-Th^{232}$ system with that of the $Pu^{239}-Th^{232}$ system. (D.C.W.)

13304 SLOW-NEUTRON SPECTRUM MEASUREMENTS ON THE PHYSICAL TEST ASSEMBLY OF I. V. KURCHATOV POWER REACTOR STATION IN BELOYARSKAYA. Yu. Yu. Glazkov, B. G. Dubovskii, G. A. Ilyasova, V. I. Kozlov, V. V. Smelov, and V. N. Sharapov. At. Energ. (USSR), 15: 481-5(Dec. 1963). (In Russian)

A subcritical test assembly, with a lattice similar to that of the Beloyarskaya Power Reactor, was used for measuring the energy spectrum of slow neutrons at the boundary region between the cell and the fuel channel by means of the time-of-flight method. The $100 \times 100 \times 100$ cm assembly, with 1.2% enriched U was placed in the center of the reactor core while fuel channels containing 2% enriched U were placed at the periphery of the core; a neutron source with a flux of less than 2×10^5 n/cm^2·sec was also placed in the center of the assembly. The measurements were carried out with and without water in the pipes and the fuel channels, using a 3000-rpm chopper con-

nected to a 128-channel analyzer with a channel width of 32 microseconds. The stainless steel detector chamber was filled to a pressure of 18 atm with He^3. At an operating voltage of 1700 v, the efficiency of the chamber for 1-ev neutrons was about 0.97. The experimentally obtained neutron distribution data were compared with the computed values, obtained under consideration of the thermalization effects. The presence of water was found to exert a softening effect on the neutron spectrum in the graphite; the temperature of the neutron gas at 0.03 to 0.2 ev was calculated at T = 400°K without, and T = 370°K with water in the channels; the latter value agrees well with the data obtained previously (Atomnaya Energ. 10, 381 (1961)). (TTT)

13305 APPLICATION OF NUMERICAL AUTOMATION IN NUCLEAR POWER PLANTS. E. Picard. p.403-6 of "Automatic and Remote Control. Vol. IV." London, Butterworths, 1961. (In French)

Digitalization in reactor safety circuits leads to a more complete automation. An example of a burst-slug-detection scanner using digital techniques is given. It is shown that the adopted solution closely follows the desired overall specifications, mostly in respect of safety considerations of the project. The digital computer used offers a large versatility due to its magnetic drum memory on which the entire program is recorded. This program can be modified and adapted to actual increase of knowledge in the reactor maintenance. The program includes numerous tests for all pneumatic, electrical, or electronic circuitry. The computing precision is 1% and the input capacity 19 bits. (auth)

13306 INDIAN POINT REACTOR PRIMARY SYSTEM THERMAL AND HYDRAULIC EVALUATION. J. C. Deddens (Babcock and Wilcox Co., Lynchburg, Va.). 5p. (CONF-187-62)

From American Nuclear Society Meeting, New York, Nov. 1963.

Flow measurements made on the primary system prior to initial criticality used to determine the primary system flow and to evaluate differences between the measured and design values are reported. Secondary heat balances made during power operation were used to determine power output. The performance of the steam generators was evaluated. The overall purpose of the tests was to evaluate the reactor performance and safety margins up to full power. (R.E.U.)

13307 BREEDING POTENTIAL OF THE LIQUID METAL BREEDER (LIMB) REACTOR. Robert J. Teitel and John B. Brown, Jr., (Douglas Aircraft Co., Inc., Santa Monica, Calif.). 34p. (CONF-187-44)

From American Nuclear Society Meeting, New York, Nov. 1963.

Data concerning the breeding ratio and doubling time possible with LIMB technology are presented. Two practical sizes, 200 and 1000 Mw(th), were chosen for more detailed evaluation. Realistic processing assumptions and their effect on the breeding ratios and doubling time were evaluated. The results show that the 200 Mw(th) has a potential breeding ratio of 1.08 and a 8.7 year doubling time. The 1000 Mev(th) reactor had a breeding ratio of 1.05 and a 12 year doubling time. Higher uranium isotopes, fission products, and Pa effects were taken into account. Using the most pessimistic estimates on processing could lead to a reduction of breeding ratio by .03 in value. On the other hand, improvements in design and utilization of low-cross-section leads or other coolants can counteract these losses. It is shown that the LIMB reactor technology can lead to an efficient breeder even in large power sources. (auth)

13308 SUMMARY OF "ENGINEERING INFORMATION OBTAINED FROM OPERATION OF ENRICO FERMI ATOMIC POWER PLANT." A. Amorosi and C. H. Clark (Atomic Power Development, Inc., Detroit). 17p. (CONF-187-42)

From American Nuclear Society Meeting, New York, Nov. 1963.

Operating experiences of the Fermi Fast Breeder Reactor are summarized. Included are the sodium primary coolant system, fuel handling, steam generators, nuclear testing, and safety rod repair. (R.E.U.)

13309 OPTIMIZATION AND SAFETY OF HELIUM COOLED FAST BREEDERS. Dieter Smidt (Kernforschungzentrum, Karlsruhe, Ger.). 24p. (CONF-334-23)

From Conference on Breeding Economics, and Safety in Large Fast Power Reactors, Argonne, Ill., Oct. 1963.

The specific power-reactor size relation is discussed. Optimum coolant temperatures, efficiency, hot spot temperature dependence on fuel geometry, safety features of gas cooling, efficiency of smooth fuel surfaces, loss-of-coolant accident prevention, and economics of heat exchangers are investigated. (R.E.U.)

13310 NUCLEAR REACTOR PLANT. (to Sulzer Freres, Societe Anonyme). British Patent 947,893. Jan. 29, 1964. Priority date Apr. 11, 1960, Switzerland.

The design of a nuclear reactor plant, in which fuel elements are located in pressure tubes through which an inorganic fluid coolant flows, is patented. The design is based on the principle that coolant flowing around the low-heat fuel elements near the edges of the reactor can have a greater exit temperature, because of the lower temperature drop in the fuel elements, than coolant flowing around high-heat fuel elements near the center of the reactor. The fuel elements are divided into at least 2 groups according to temperature. The coolant coming from the fuel-element group with the least evolution of heat is at the highest temperature and is used as the working medium, thereby increasing the efficiency of the plant. The coolant is preheated in fuel element groups having a greater evolution of heat before entering the group with the least evolution of heat. Details of the coolant and working medium circuits are described. (M.P.G.)

13311 NUCLEAR REACTOR. (to North American Aviation, Inc.). British Patent 949,743. Feb. 19, 1964. Priority date Aug. 1, 1961, United States.

An improved organic-moderated and -cooled power reactor is designed for operation with increased power density and low fuel costs. The ratings of the reactor are 160 Mw(t) and 56 Mw(e). The reactor uses a mixture of terphenyls as coolant, and its core is aligned and mounted from a single bottom plate, simplifying the arrangement and removal of components. (D.L.C.)

Propulsion and Space

Refer also to abstracts 12852 and 13051.

13312 (AFSWC-TDR-62-144) SNAP 2/10A GROUND TEST PROGRAM, PHASE I. John D. Belson (Air Force Special Weapons Center, Kirtland AFB, N. Mex.). Mar. 1963. 79p. (AD-406123)

Tests of the SNAP 2/10A Reactor Ground Test Program to determine the structural behavior of the SNAP 2/10A reactor assemblies when subjected to thermochemical,

fire, explosive and impact environments are discussed. (auth)

13313 (BAW-1264) NS SAVANNAH SAFEGUARDS REPORT FOR 80-MW OPERATION. R. C. Luken (Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va.). Feb. 1963. Contract AT(30-1)-2847. 30p.

Operation of the NS Savannah has demonstrated that with certain sea conditions a reactor power greater than 69 Mw is desirable. The design and operating characteristics of the power plant equipment have been reviewed and have been found to be adequate to permit operation at a steady-state reactor power of 80 Mw. Transient operation and potential accidents to the power plant have been reviewed and demonstrate that the increasing of reactor power to 80 Mw can be accomplished without significantly affecting the existing safety margins. Operation at 80 Mw increases the maximum fission-product inventory of the core by 16% for the maximum credible accident. However, the accepted operating procedures for the ship limit the allowable operating reactor power as necessary to minimize the potential environmental hazard to the general public. In the open sea the ship and its occupants are under direct control of the crew. All passengers and non-essential crew members will be directed to the area of least radiation. Strict control of radiation dose will be enforced by personnel trained in health physics to limit an individual person's integrated dose to acceptable values. It is concluded, therefore, that the NS Savannah can be operated at 80 Mw without compromising the existing safety of the ship. (auth)

13314 (GA/Phys/63-2) A HEAT TRANSFER STUDY OF A NUCLEAR ROCKET REACTOR (thesis). Charles Frederick DeMos (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio). Aug. 1963. 73p. (AD-419313)

A digital computer program was developed to investigate the coolant temperature and pressure and the material temperatures in a nuclear rocket reactor. The reactor uses hydrogen gas as the coolant and is operating under steady-state conditions. The program is written in FORTRAN for execution on an IBM 7090 digital computer. Reactor geometry, input conditions of the coolant, power, power distribution, and reactor fuel thermal conductivity are variable input qualities. The hydrogen is treated as a perfect gas and the reactor is assumed to be perfectly insulated. The coolant and material temperatures are determined by an iterative technique. The transport properties of hydrogen are computed by empirical formulas which include the effect of both temperature and pressure. The FORTRAN source program, operating instructions, a sample problem, and sample output data are included as appendices. The sample problem is a study which results in optimum propellant mass rate-of-flow and flow tube interior diameter for a given pressure drop and exit temperature. (auth)

13315 (GEMP-231) 630A — MARITIME NUCLEAR STEAM GENERATOR. Status Report No. 1. (General Electric Co. Advanced Technology Services, Cincinnati). Sept. 12, 1963. Contract AT(40-1)-2847. 284p.

The current status of the 630A Nuclear Steam Generator is reported. The 630A Nuclear Steam Generator consists of an air-cooled, water-moderated reactor using metallic fuel elements, a once-through water tube boiler, two axial-flow blowers, lead and water shielding, controls, and necessary auxiliary equipment. The design, safety features, overall configuration, and operating cycle for a 27,300-SHP version of the 630A are summarized. Information is included on the design and characteristics of the reactor shield plug assembly, boiler, pressure vessel, shield containment vessel, shield, nuclear steam generator accessories, handling and service equipment, fuel elements, control systems, control rods, cooling systems, critical experiments, power cycles, and blower systems. A discussion is included on the need for a maritime fleet and the technology which led to the decision to develop the 630A system. A summary is included for capital and operating costs, safety hazards, ANP reactors, alternate configurations, computer programs, specifications, operating conditions, and future development. (N.W.R.)

13316 (NAA-SR-Memo-9203) STRUCTURAL ANALYSIS OF SNAP 2 REACTOR VESSEL TOP HEAD. C. C. Rampton (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 14, 1962. Contract [AT(11-1)-Gen-8]. 35p.

The top head of the SNAP-2 reactor vessel was analyzed and found to be adequate for the assumed conditions. Discontinuity stresses in the spherical shell at the junction of the NaK outlet pipe and at the perimeter of the shell during assumed launch vibration were calculated. A maximum stress of 29,700 psi was calculated at the NaK outlet junction and a maximum stress of 33,200 psi was calculated near the perimeter of the spherical shell. The maximum membrane stress in the head was found to be 7,900 psi for short duration loads and 5,250 psi for long duration loads. These stresses indicate that, at a temperature of 1250°F, the creep of the head will be less than 1% in 10,000 hours. Discontinuity loads on the reactor vessel were also calculated for the assumed launch vibration. (auth)

13317 (NASA-TM-X-28) DESIGN ANALYSIS OF A SUBSONIC NUCLEAR-POWERED LOGISTIC AIRPLANE WITH HELIUM-COOLED REACTOR. R. H. Cavicchi, H. H. Ellerbrock, E. W. Hall, H. J. Heppler, J. N. B. Livingood, and F. C. Schwenk (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Oct. 23, 1959. 245p.

A detailed design analysis of a nuclear-powered turboprop logistic airplane with a helium-cooled reactor was made to determine how the nuclear and engine components might look, whether any unforeseen difficulties might arise in the design, and what research is most needed to support such a system. A 400,000-pound-gross-weight airplane designed for 0.72 flight Mach number at 30,000 feet was selected as the reference airplane. The resulting wingspread and fuselage length are 250 and 175 feet, respectively; and reactor power of 98.5 megawatts is required. Chemical fuel is provided for thrust augmentation for takeoff, landing, and emergency use. For emergency, part of the neutron shield is assumed to be chemical fuel. Each of eight 4600-horsepower turboprop engines required is supplied with air at 1800°R turbine-inlet temperature from its separate heat exchanger. Mounted in the wings, the heat exchangers receive helium at 2250°R from the reactor. A helium pump, absorbing about 24% of the engine power, is required with each heat-exchanger unit. The airplane can be either logistic (carrying passengers and/or freight) or patrol type. A unit shield designed to limit the dose rate in the crew compartment to 0.025 rem per hour is provided. This limit allows approximately 40 hours of flight every 2 weeks. On the basis of the assumptions of the analysis, the following weight breakdown seems reasonable: Aircraft structure, 108,000; equipment, 22,000; powerplants, 83,000; shield and reactor, 120,000; payload, 63,000; and chemical fuel for takeoff and landing, 4000 pounds. The heat-exchanger temperature limits the performance. Research on the reactor (especially the fuel elements), the heat exchangers, the pumps, and the helium leakage problem is required. (auth)

13318 (NASA-TN-D-2124) TWO-DIMENSIONAL GRAY-GAS RADIANT HEAT TRANSFER IN A COAXIAL-FLOW GASEOUS REACTOR. Robert G. Ragsdale and Thomas H. Einstein (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Feb. 1964. 29p.

A two-dimensional radiation heat-transfer analysis was applied to a cylindrical system of coaxially flowing gray gases (constant absorption coefficient) in which the inner stream contains a radially uniform distribution of volumetric heat sources. For slug-flow velocity profiles in both streams, the following conditions were selected: (1) a cavity diameter of 10 feet, (2) cavity lengths of 10, 15, and 20 feet, (3) a heat-generating-core diameter of 2 feet, (4) propellant flow rates up to 33 pounds per second, (5) propellant- to fuel-flow-rate ratios from 24 to 240, (6) an inlet gas temperature of 5000° R, and (7) outlet gas temperatures varying from 7000 to 12,200° R. Radiative end losses were accounted for by assuming the inlet end of the reactor to be at the inlet gas temperature, and the outlet gas end to be at the cylinder wall temperature. Both end surfaces were assumed to be black and porous to the flow. The absorption coefficient, reactor length, and flow parameters were varied over a range of conditions. Based on these assumptions, the following conclusions were reached. For a 10-foot-diameter reactor and an absorption coefficient of 2 per foot, the heat load on the channel wall was less than 1 percent of the generated power, and the maximum wall heat flux was 12 Btu per second per square inch. The temperature of the heat-generating core is relatively constant over the length of the reactor. Wall heat flux is not significantly affected by the core velocity. From the standpoint of radiant heat transfer, for any given reactor diameter, a small value of cavity length to diameter ratio is desirable for gaseous-reactor application. The heat radiated to the reactor wall comes primarily from the hydrogen immediately adjacent to it. Therefore, the wall heat flux is strongly affected by the propellant (outer stream) flow rate and absorption coefficient and by channel dimensions, but it is not directly affected by changing conditions in the central core itself. (auth)

13319 (UCRL-6146(Pt.II)) A SUMMARY OF TORY II-A AEROTHERMODYNAMICS. PART II. P. M. Uthe, ed. (California. Univ., Livermore. Lawrence Radiation Lab.). Dec. 28, 1960. Contract W-7405-eng-48. 122p.

The digital computer codes used for the aerothermodynamic calculations that were involved in evaluating the Tory II-A reactor are described. (auth)

13320 PROBLEMS OF SOURCES OF NUCLEAR POWER FOR ELECTRIC DRIVES. G. F. Au (Deutsche Forschungsanstalt für Luft- und Raumfahrt eV, Brunswick). Atompraxis, 10: 1-7(Jan. 1964). (In German)

Sources of nuclear power are of great importance for space missions. There is no possibility for other power sources to spend the necessary electric power for the electric drive because they cannot stand a comparison with nuclear power plants in specific efficiency and working time. Some advantages of the thermionic transformation of energy compared with the turboelectric method are given. The present technology does not allow selection of a suitable reactor coolant. Problems of the optimum of a total plant, including electric transformers and current transformers, are discussed. (P.C.H.)

13321 SNAP REACTOR SYSTEMS: NUCLEAR POWER IN SPACE. R. Balent (Atomics International, Canoga Park, Calif.). Atompraxis, 10: 7-10(Jan. 1964).

Power supply, vehicle configuration, mission objective, number of men, mission time, weight, volume, and area assignable to the power supply are discussed regarding the SNAP program. Special attention is given to power supplies. (P.C.H.)

13322 POWER SUPPLIES FOR SPACE VEHICLES. W. Peschka (Deutsche Versuchsanstalt für Luft- und Raumfahrt eV, Porz-Wahn, Ger.). Atompraxis, 10: 10-17(Jan. 1964). (In German)

Problems associated with the development of power sources for space vehicles are discussed. (P.C.H.)

13323 NUCLEAR ENERGY AND SPACE TRAVEL. D. Wragge-Morley. Atompraxis, 10: 25-8(Jan. 1964).

Problems, economics, and technical difficulties in the application of nuclear power in its various different forms for space travel are discussed. The step from the SNAP-Program to rocket propulsion by nuclear power is considered. (P.C.H.)

13324 AUTOMATIC ELECTRIC PROPULSION SYSTEM DRIVE OF THE NUCLEAR-POWERED ICE-BREAKER LENIN. V. L. Bershadski, V. K. Kalashnikov, V. V. Kryazhevski, L. V. Maziya, and G. A. Popov. p.138-43 of "Automatic and Remote Control. Vol. IV." London, Butterworths, 1961.

The electric propulsion system of the ice-breaker Lenin is described, together with the static characteristics of the shaft drive. Curves for the transmission processes are given, based both on calculation of the system on electronic computers and on actual trials in the ice-breaker. (auth)

13325 SNAP NUCLEAR REACTOR ENVIRONMENTAL PROBLEMS. Stuart Giles (Atomics International, Canoga Park, Calif.). p.395-9 of "Institute of Environmental Sciences, 1963 Annual Technical Meeting Proceedings." Mt. Prospect, Ill., Institute of Environmental Sciences, 1963.

Environmental problems presented to SNAP programs are discussed. Simulation testing of components is discussed. (R.E.U.)

13326 PROBLEMS OF REACTOR OPERATION IN A SPACE SIMULATOR. C. C. Miesse and E. W. Lohr (Westinghouse Electric Corp., Pittsburgh). p.465-74 of "Institute of Environmental Sciences, 1963 Annual Technical Meeting Proceedings." Mt. Prospect, Ill., Institute of Environmental Sciences, 1963.

Problems involved in the environmental testing of nuclear reactor systems are introduced by the radioactive hazard to operating personnel and the radiation effects on materials required for the proper functioning of the simulation facility and test vehicle. The ultimate objective thus becomes the establishment of design criteria for a nuclear-cryogenic system in which maximum simulation is achieved with a minimum probability of radiation damage or personnel hazard. Time lost due to replacement of irradiated equipment must be weighed against the additional cost and complication of installing shielding and/or radiation-resistant materials. Major problems considered in the design of such a unique facility include activation of equipment and structures, degradation of component functions, contamination, shielding, and disposal of radioactive wastes. 29 references. (auth)

13327 CAVITY NUCLEAR REACTORS. R. J. Holl and T. F. Plunkett (Douglas Aircraft Co., Inc., Santa Monica). 22p. (CONF-187-45)

From American Nuclear Society Meeting, New York, Nov. 1963.

A nuclear analysis was performed for cavity nuclear

reactors suitable for space propulsion. Calculational methods were evaluated and multigroup diffusion theory was selected. A survey in spherical geometry-evaluated reflector materials, nuclear fuels, reactor dimensions, and temperature effects is presented. Two-dimensional results for a finite cylindrical reactor are included. The study showed that extremely high fuel loadings were required for a propulsion reactor. (auth)

Research and Test Reactors

13328 (AID-P-63-53) SOVIET NUCLEAR RESEARCH REACTORS OF THE IRT-2000 TYPE. Review of Soviet Literature. AID Work Assignment No. 31, Report 6. (Library of Congress. Aerospace Information Div., Washington, D. C.). Apr. 30, 1963. 33p. (AD-403811)

This summary presents a detailed description of six Soviet experimental reactors of the IRT-2000 type, viz.: the Moscow IRT-2000 reactor, the Salaspils IRT-2000 reactor, the Tbilisi IRT-2000 reactor, the Tomsk IRT-2000 reactor, the Sverdlovsk IRT-2000 reactor, and the Malyye Dubny IRT-2000 reactor. (The name of each reactor indicates the city in which it is located.) The presentation includes background information, design features, reactor parameters, and information on experimental facilities and experiments conducted with the reactors, together with illustrations and diagrams. The report is based on Soviet open literature. (auth)

13329 (AID-P-63-60) SOVIET RESEARCH REACTORS VVR-M (LENINGRAD) AND VVR-M (KIYEV). Summary of Data. AID Work Assignment No. 31, Report No. 7. (Library of Congress. Aerospace Information Div., Washington, D. C.). May 10, 1963. 14p. (AD-404911)

Two Soviet water-moderated and -cooled reactors (advanced VVR-M's) are described. Background information, construction details, control and safety system features, reactor physics, heat transfer characteristics, and experimental facilities are covered. (auth)

13330 (AID-P-63-88) SOVIET NUCLEAR RESEARCH REACTOR VVR-Ts. Summary of Data. AID Work Assignment No. 31 (Report No. 8 in this Series). (Library of Congress. Aerospace Information Div., Washington, D. C.). July 3, 1963. 22p. (AD-411882)

The pool-type VVR-Ts thermal reactor developed from the VVR-S reactor and located at Alma-Ata is described, together with the associated experimental facilities. Background information, design features, and reactor parameters are included. (D.C.W.)

13331 (DP-801) CORROSION RESULTS FROM THE HEAVY WATER COMPONENTS TEST REACTOR. J. Malvyn McKibben (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Jan. 1964. Contract AT(07-2)-1. 32p.

Before construction of the Heavy Water Components Test Reactor, the mild steel piping and equipment to be installed were cleaned with an alkaline rust remover, and stainless steel materials were washed with detergent. After construction was completed, the system was rinsed thoroughly with deionized water and treated with deoxygenated water at 240°C and a pH of 10.5 for 13 days to produce an adherent coating of magnetite (Fe_3O_4). General corrosion was slight during rinsing and treating, although some areas pitted to maximum depths of 1 mil. (auth)

13332 (KFK-177) MESSUNGEN AM REAKTOR FR2 NACH DER WIEDERINBETRIEBNAHME. (Measurements on the FR-2 Reactor After New Startup). H. W. Glauner, S. Hagen, and M. Diederichs (Kernforschungszentrum, Karlsruhe, Germany). July 1963. 45p.

In November 1962 the FR-2 was again placed in operation with a new aluminum tank and a new steel tank. A series of measurements were made of the power after startup. Flux measurements with tube counters in the shutdown reactor, reactivity measurements, operation of a pile oscillator, power determination for fuel elements, flux measurements with activation probes, and flux measurements with a beta-flux rhodium detector are described. Results are shown in graphs. (M.C.G.)

13333 (LAMS-3036) QUARTERLY STATUS REPORT ON ULTRA HIGH TEMPERATURE REACTOR EXPERIMENT (UHTREX) FOR PERIOD ENDING DECEMBER 20, 1963. (Los Alamos Scientific Lab., N. Mex.). Jan. 1964. Contract W-7405-eng-36. 23p.

The development and construction progress made on the Ultra High Temperature Reactor Experiment (UHTREX) is reported. Information is included on reactor components, core flow models and tests, helium blower tests, helium cooling system development, dynamic system analysis using UHXCOM simulation program, fuel cell calculations, shutdown rod worths, fuel loading, and fuel preparation. (N.W.R.)

13334 (NASA-TN-D-1725) TECHNIQUES USED TO MEASURE THE HYDRAULIC CHARACTERISTICS OF THE NASA PLUM BROOK REACTOR. Joseph M. Savino and Chester D. Lanzo (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Aug. 1963. 70p.

Techniques used to measure the reactor flow characteristics are described, and a flow problem that was encountered is described, together with the changes that corrected it. Once the modifications were made, coolant flow rates and pressure distributions of all the reactor components satisfied design requirements for full-power and shutdown operations. Removable rakes with total- and static-pressure probes measured the velocity and static-pressure distributions among the fuel-cooling channels of the assemblies and rod. Similar probes for use in the core tests were perfected, and found to be accurate, fast responding, and highly dependable. Velocity and static-pressure distributions and overall pressure losses were within design requirements. A pair of simulated fuel assemblies, each containing a turbine flowmeter, were built to have the same overall pressure loss against flow rate characteristics as the typical Plum Brook Reactor fuel assemblies. These instruments measured the steady flow rates in all the fuel-assembly positions of the core to within 1%. Flow rates were measured throughout the coastdown period. The time required for the flow rate to decrease to 10% of the full flow value was 15 sec. (auth)

13335 (NP-13597) DESCRIPTION OF THE HIGH FLUX RESEARCH REACTOR "R2," TO BE BUILT AT STUDSVIK, SWEDEN, BY THE SWEDISH ATOMIC ENERGY COMPANY (AKTIEBOLAGET ATOMENERGI). (Aktiebolaget Atomenergi, Stockholm). Sept. 6, 1957. 32p.

The light-water-moderated, pool-type reactor is described. The design power is 30 Mw (thermal), and fast fluxes of 2.4×10^{14}–10^{15} neutrons/cm^2 are expected at the center of the core. Systems, uses, costs, facilities, operational organization, fuel requirements, and hazards control are covered. (D.C.W.)

13336 (NRL-Memo-1481) ENCAPSULATION TECHNIQUES FOR NRL IRRADIATION EFFECTS STUDIES. L. E. Steele and J. R. Hawthorne (Naval Research Lab., Washington, D. C.). Dec. 1963. 26p.

Various systems and techniques for encapsulation of irradiation experiments have been devised in the course of several years of research using several AEC test reactor facilities. A capsule design philosophy has evolved which is based upon the use of two types of capsules, sealed units and externally controlled units for the irradiation of large numbers of metallurgical specimens under a range of thermal and nuclear conditions. The basic philosophy of capsule design is described along with specific techniques utilized for various test reactor capsules and for long-term power reactor surveillance capsules. (auth)

13337 (ORNL-TM-661) THERMAL-FATIGUE ANALYSIS OF THE HFIR TARGET IRRADIATION PROTOTYPE. J. T. Venard and A. E. Carden (Oak Ridge National Lab., Tenn.). Feb. 17, 1964. Contract W-7405-eng-26. 16p.

Generation of heat due to neutron bombardment of the High-Flux Isotope Reactor Target Irradiation Prototype will produce thermal straining of the assembly. Because these thermal strains are not uniformly distributed throughout the target, mechanical strains and associated thermal stresses will be present in the target during operation. Cyclic reactor operation (start-up and shutdown) may lead to a failure of the target by a thermal-fatigue mechanism. Due to the complex nature of the assembly (finned target rod and restraining hex can), the target is separated into simple elements for analysis. Each element is analyzed independently and the resulting deformations are superposed according to strain compatibility requirements. A prediction of the fatigue life of the pertinent elements is made by relating the above results to an established mechanical strain-fatigue criterion. A recommendation is made for relieving the most serious instance of thermally induced mechanical straining by removing the axial restraint at the target ends. (auth)

13338 (ORNL-TM-710) EFFECTS OF VARIOUS REFLECTORS ON THE REACTIVITY OF THE HEALTH PHYSICS RESEARCH REACTOR. L. W. Gilley (Oak Ridge National Lab., Tenn.). Feb. 1964. Contract W-7405-eng-26. 16p.

The reactivity worths of several Plexiglas reflectors on the HPRR were measured in order to obtain a basis for predicting the effects of proposed experiments with the reactor. The reactivity contributions from the reactor safety cage and crash plate and from the reactor building floor and a reactor storage pit were also evaluated. (auth)

13339 OTR—HIGHER TEMPERATURES FOR WHITESHELL. Can. Chem. Process., 46: 70-2(Feb. 1962).

Preliminary design and development work on the Organic Test Reactor are discussed. (C.E.S.)

13340 ZERO POWER TRANSFER FUNCTION MEASUREMENTS. H. G. Ebersbach, P. Liewers, and J. Scholz (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Kernenergie, 6: 667-72(Dec. 1963). (In German)

The reactor transfer functions of the Rossendorf Research Reactor at low power (500 w) were measured. From adapted calculations a value of $\beta_{eff}/l = (103 \pm 11)$ sec^{-1} was obtained. The validity of the adapted calculations for the necessary theoretical transfer functions is discussed. (tr-auth)

13341 PHYSICS CALCULATIONS FOR THE PHILIPPINE OPEN-POOL REACTOR PRR-I. B. FLUX DISTRIBUTION AND EXCESS REACTIVITIES. Jose O. Juliano, Pericles T. Meneses, and Cesar L. Pineda (Philippine Atomic Energy Commission, Manila). Philippine J. Sci., 92: 185-93(June 1963).

Two-group neutron diffusion theory was used to determine the effects of using different thicknesses of graphite reflectors, in conjunction with an infinite thickness of light water in the Philippine Open-Pool Reactor, on reactivity. (R.E.U.)

13342 AUTOMATIC CONTROL OF RESEARCH REACTORS. J. D. Le Franc. p.394-8 of "Automatic and Remote Control. Vol. IV." London, Butterworths, 1961. (In French)

The most numerous control-technique equipment for nuclear research reactors consist of an arrangement for stabilization of the power at a given value or for automatic adjustment of this power to that level, which is selected by the researcher. One such control circuit is described in detail: that used for stabilization of the MINERVE Reactor. This control circuit consists of an ionization chamber, an amplifier with stabilized direct current, a computer for error information, and a magnetic amplifier series, which acts on the drive motor of a rotatory rod, which plunges the element in the reactor. Some curves are shown, which were obtained on an analog computer and which represented the performance of the arrangement. (tr-auth)

13343 ELECTROMAGNETS FOR THE BULK SHIELDING REACTOR (BSR-II) (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-955)

This package contains 13 drawings. The drawings describe high-load-capacity canned magnets of consistently uniform quality that were designed for the BSR-II. Rapid, spring-accelerated, safety rod insertion is substituted in the BSR-II for the simple gravity drop of safety rods used in BSR-I. Fabrication techniques minimized the internal air gap and produced maximum performance from the magnet material by using the same amount of space that was used in the PCA magnet of BSR-I. (F.S.)

WASTE DISPOSAL AND PROCESSING

Refer also to abstract 12393.

13344 (EIR-56) DIE LAGERUNG VON RADIOAKTIVEN ABFAELLEN IM EIDGENOESSISCHEN INSTITUT FUER REAKTORFORSCHUNG IN WUERENLINGEN. (Storage of Radioactive Wastes at the Federal Institute for Reactor Research in Wurenlingen). K. F. Eschle (Switzerland. Eidgenössisches Institut für Reaktorforschung, Würenlingen). Aug. 1963. 16p.

The storage of radioactive wastes is discussed. Storage buildings and tanks were built on the basis of an estimated total volume of 3000 to 4000 m^3, corresponding to an activity of about 20,000 C. (M.C.G.)

13345 (IDO-14624) REMOVAL OF RADIOISOTOPES FROM SOLUTION BY EARTH MATERIALS FROM EASTERN IDAHO. M. W. Wilding and D. W. Rhodes (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Nov. 8, 1963. Contract AT(10-1)-205. 64p.

Naturally occurring earth materials from Idaho, many of which were from localities near the National Reactor Testing Station (NRTS), were used in laboratory tests to determine the most likely candidates for decontaminating low-level radioactive wastes at the NRTS. It was concluded that the material containing a high content of clinoptilolite was the most promising candidate for the following reasons: (1) excellent physical and chemical stability, (2) a cation exchange capacity of about 0.3 milliequivalent per gram, (3) ability to remove radioisotopes from solution over a wide pH range, and (4) the ready availability of thousands of tons of the raw material at a location near the NRTS. This conclusion was based on the results of column breakthrough experiments and batch equilibrium-type tests. The distribution coefficients of this material for cesium and strontium were determined to be greater than 1000 at favorable pH values. A brief study of the effect of complexing agents on the reaction of radioisotopes with the earth materials indicated that citrate depressed the absorption of ruthenium markedly and that EDTA depressed the adsorption of strontium, cobalt, and ruthenium more than the adsorption of cerium and chromium. (auth)

13346 (TID-19941) PROCESS AND WASTE CHARACTERISTICS AT SELECTED URANIUM MILLS. Technical Report W62-17. (Robert A. Taft Sanitary Engineering Center, Cincinnati). 1962. 98p.

Five papers are presented on the results of detailed studies of process and waste flows at five typical uranium mills. Separate abstracts were prepared for all five of the papers. (D.L.C.)

For abstracts of individual papers see: 13347, 13348, 13349, 13350, and 13351.

13347 (TID-19941(p.1-18)) THE RESIN-IN-PULP URANIUM EXTRACTION PROCESS. MINES DEVELOPMENT COMPANY, EDGEMONT, SOUTH DAKOTA. E. C. Tsivoglou, D. C. Kalda, and J. R. Dearwater.

A field study was carried out on liquid wastes from the extraction of U from its ore in the Edgemont refinery using the resin-in-pulp extraction process. The process is analyzed in detail. The study of the wastes was conducted with particular attention to the radium balance throughout the mill and in the wastes. The results show that, although the wastes contain ~0.6 mg radium/ton ore processed or a total of ~300 mg/day, 99.8% of the radium remained in undissolved form and was effectively retained in the sands and slimes tailings pond. The waste disposal practice and monitoring of wastes at other mills are discussed. (D.L.C.)

13348 (TID-19941(p.19-36)) THE ACID LEACH-SOLVENT EXTRACTION URANIUM REFINING PROCESS. I. GUNNISON MINING COMPANY, GUNNISON, COLORADO. S. D. Shearer, C. E. Sponagle, J. D. Jones, and E. C. Tisvoglou.

The results of an in-plant survey of the Gunnison U refinery and its wastes are reported. The acid leach solvent extraction process is analyzed, and the resulting liquid waste was characterized at several sampling stations. The results show that two waste constituents, Ra^{226} and arsenic, are present in potentially hazardous quantities, but that Ra^{226} stayed mainly in the undissolved state through the entire process. The flow records of Gunnison River are analyzed for the dilution available for possible future effluent discharges. (D.L.C.)

13349 (TID-19941(p.37-54)) THE ACID LEACH-SOLVENT EXTRACTION URANIUM REFINING PROCESS. II. CLIMAX URANIUM COMPANY, GRAND JUNCTION, COLORADO. J. B. Cohen, C. E. Sponagle, R. M. Shaw, J. D. Jones, and S. D. Shearer.

An in-plant survey was conducted at the U refinery at Grand Junction, Colorado. The mill process and the waste pond arrangement are described. Samples were taken from the mill process for analysis of the gross activities and Ra^{226} concentrations. Waste disposal is discussed. (D.L.C.)

13350 (TID-19941(p.55-71)) THE CARBONATE LEACH URANIUM EXTRACTION PROCESS. I. HOMESTAKE-NEW MEXICO PARTNERS COMPANY, GRANTS, NEW MEXICO. J. B. Cohen, H. R. Pahren, and M. W. Lammering.

Results are reported of an in-plant survey of a U refinery using the carbonate leach extraction process for the separation of U from its ore. The process is described. The survey results are presented in the form of activities and Ra^{226} concentrations; they were derived from field data, laboratory analyses, and flow balances. Waste disposal is discussed. (D.L.C.)

13351 (TID-19941(p.73-91)) THE CARBONATE LEACH URANIUM EXTRACTION PROCESS. II. HOMESTAKE-SAPIN PARTNERS, GRANTS, NEW MEXICO. H. R. Pahren, M. W. Lammering, and J. Hernandez.

Results are reported of an in-plant survey of the Homestake-Sapin mill which uses the carbonate leach extraction process. The process is described. The results are presented in the form of activities and Ra^{226} concentrations, and the discrepancies in the data are discussed. Finally, the waste disposal is considered. (D.L.C.)

13352 THE ELIMINATION OF RADIOACTIVE EFFLUENTS. P. Bovard and M.-E. Gahinet. Eau, L, 50: 301-6(May 1963). (In French)

The sources of radioactivity in water are discussed, together with the treatment and release of radioactive effluents. Controls on release and activity levels are also indicated. (D.C.W.)

13353 THE DESIGN OF A RADIOACTIVE WASTE STORE. R. Oliver and F. J. Stubbs (Oxford Univ.). Health Phys., 10: 69-71(Feb. 1964).

Arrangements for the storage and disposal of radioactive waste and the design of a central Radioactive Waste Store for use by all science departments at Oxford University are described. The scheme is described for liquid and solid wastes and animal carcasses. (P.C.H.)

GENERAL AND MISCELLANEOUS

13354 (BMI-1657(Del.)) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING NOVEMBER 1963. Russell W. Dayton and Ronald F. Dickerson (Battelle Memorial Inst., Columbus, Ohio). Dec. 1, 1963. Contract W-7405-eng-92. 71p.

Research and development progress is reported on reactor materials and components, studies of fuels, general fuel element development, radioisotope and radiation applications, development of a tracer system for in-place filter evaluation, coated-particle fuel materials, corrosion studies of the fluoride-volatility process, progress on USAEC-AECL cooperative program, fission-product deposition studies, gas-cooled reactor program, and joining of regenerative cell components. (M.C.G.)

13355 (ISS-63/39) IL SEMINARIO DEI LABORATORI DI FISICA NEL QUADRIMESTRE MAGGIO–AGOSTO 1963. (The Seminar at the Physics Laboratory During the Period May–August 1963). (Italy. Istituto Superiore di Sanita, Rome). Sept. 9, 1963. 74p.

Summaries of fifteen of the lectures held at the Physics Laboratory in the May–August quarter are presented. (J.S.R.)

13356 (LAMS-3028) SOME ETHICAL AND SOCIAL PROBLEMS OF SCIENCE AND TECHNOLOGY: A BIBLIOGRAPHY OF THE LITERATURE FROM 1955. J. Arthur Freed, comp. (Los Alamos Scientific Lab., N. Mex.). Sept. 1, 1963. Contract W-7405-eng-36. 48p.

Three hundred eighty-nine references are presented covering material published in English from 1955 to date dealing with ethical and social problems of science and technology. Emphasis is placed on professional integrity of scientists, the social responsibility of scientists, and the role of the Federal Government in science and technology. (C.H.)

13357 (MLM-1148) PROGRESS REPORT [ON RESEARCH], JANUARY 1963. J. F. Eichelberger, G. R. Grove, L. V. Jones, and E. A. Rembold (Mound Lab., Miamisburg, Ohio). Jan. 30, 1963. Contract AT-33-1-GEN-53. 28p.

Five conductive carbon blacks for use as fillers for a polyurethane adhesive are being evaluated. The lowest electrical resistivity, 2.0 ohm-cm, was obtained by adding 35 wt % Continex CF carbon black as a filler to the basic adhesive formulation. In studies of carbon isotope separation the approximate values of column transport parameters for carbon monoxide were determined. The separation factor for the isotopic exchange of C^{13} in carbon monoxide was calculated as a function of temperature. The counting plateau characteristics of mixtures of xenon and methane are being investigated to develop a low-level counter to determine Kr^{85} in xenon. For mixtures of xenon and methane, both operating voltage and breakdown voltage increased with chamber pressure. The counting rate at operating voltage increased with gas pressure, but the plateau width did not vary uniformly with pressure. A review of the data indicated that a 90 : 10 mixture of xenon and methane (previously believed to be the optimum mixture) may not be the optimum mixing ratio. The half life of Ra^{223} was determined by the decaying pair method from ten samples prepared for alpha counting from a portion of the solution which was used in a calorimetric determination of the half life. The weighted grand mean calculated from the data yielded by the 10 samples (45 pairs) was 11.4205 ± 0.0058 days. This value is in good agreement with the calorimetric results. A process was developed to separate U^{234} from aged Pu^{238}. The various isotopes in process samples are being identified by alpha pulse height analysis. The radioisotopic impurities in the polonium waste disposal process were tentatively identified. Most of the nuclides were due to irradiated impurities in the aluminum jacket. The possible errors in the current method for determining the neutron emission of sources were analyzed. Errors other than those due to spectral differences in counting statistics are less than 0.5%. The uncertainties are less than 2% for most sources when the spectral uncertainties are added. A method is being developed to determine the amount of polonium so that the amount of polonium on an unfinished alpha source can be adjusted to the desired value before the source is sealed. A translucent fluorescent screen backed by silicon solar cells, which will give a direct meter reading proportional to the alpha emission, is being evaluated. A variational method of applying least squares to curve fitting for analyzing calorimetry data was analyzed. The main advantages of the variational method over the general method are that additional data can be added from separate experiments after a solution was found, and the variational method will give a better probable error in nonlinear cases. (auth)

13358 (MLM-1151) MOUND LABORATORY PROGRESS REPORT FOR FEBRUARY 1963. J. F. Eichelberger, G. R. Grove, L. V. Jones, and E. A. Rembold (Mound Lab., Miamisburg, Ohio). Feb. 30, 1963. Contract AT(33-1)-Gen-53. 28p.

The Jones and Furry thermal diffusion column theory was used to estimate relative values of separation per unit length for Xe^{131} and Xe^{136}. The calculations show that separation rates can be increased by operating the thermal diffusion column at high pressures using small distances between the hot and cold wall. A thermal diffusion cascade system, consisting of six hot-wire and three concentric-tube columns, was designed to enrich C^{13} from 60 to 90% using methane as a feed gas. Experimental measurements on a similar cascade indicated that the impurities would be less than 15% if the feed was 99.5% methane. It was shown that, in the "known" half life method for determining the resolution time of a counting system, two significant sources of error are unrecognized: a small absolute error in the "known" half life can produce a relatively large error in the value computed for the resolution time; and the use of unweighted counting data, which has the effect of over-weighting the relatively unreliable lower end of the decay curve, produces inaccurate and imprecise results. The radioisotopes in a waste stream from the polonium process were identified as Fe^{59}, Co^{60}, Se^{75}, Ag^{110m} and Sb^{124}. Zn^{65}, one of the principal impurities, could be removed by hydroxide precipitation. Differential thermal analysis data were taken on potassium plutonium sulfate, plutonium sulfate, and potassium sulfate. An expression for the solubility product control was derived and is being checked. Calculations were completed for the shielding required to protect personnel from gamma radiation from a 1 kg source of Pu^{238}. Thicknesses of lead, iron, uranium, and concrete that would be required to reduce the total gamma radiation to one milliroentgen per hour at one meter were found to be 0.065, 1.47, 0.19, and 9.78 cm respectively. The half life of Th^{227}, calculated using a double variation of the growth curve of Ac^{227}, was calculated to be 18.729 ± 0.048

days. This corresponds to a measured half life of 21.772 ± 0.004 years for Ac^{227}, and to 11.434 ± 0.005 days for the half life of Ra^{223}. An electron multiplier was installed in the cycloid tube of a CEC Model 21-620-A mass spectrometer. The high gain of the multiplier (approximately 10^5) will aid in the detection of trace impurities and will increase instrument sensitivity by a factor of 100. The counting of individual ions will also be possible because of the inherently fast response time of the multiplier. Heavy metal ions were reduced with sodium borohydride at pH 3.0. Of these metals bismuth, copper, nickel, palladium, and antimony precipitated quantitatively at a pH of 2. The pH of the solution increased to nine during the course of the precipitation. (auth)

13359 (MRC-451) AN APPARATUS FOR THE STUDY OF SOLID STATE ELECTROLYSIS IN HIGH-PURITY IRON. Quarterly Report No. 7, October 1, 1963–December 31, 1963. E. J. Hughes, P. W. Barton, and R. D. Vigue (Materials Research Corp., Orangeburg, N. Y.). Feb. 6, 1964. Contract AT(30-1)-2980. 13p.

The design and construction of an apparatus for the further purification of electron beam zone refined iron by solid state electrolysis is described. Some preliminary experiments have been carried out with it and the results of these are reported. (auth)

13360 (NAA-SR-Memo-9181) NAA PROGRAM DESCRIPTION. HELCØ—THE CALCULATION OF ANGULAR MOMENTUM OF FLUIDS FLOWING THROUGH A DOUBLE HELICAL PIPING SYSTEM. J. G. Morgan (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 1963. Contract [AT (11-1)-Gen-8]. 35p.

The analysis and a computer program to calculate the angular momentum of fluids flowing at a constant mass flow rate through a double helical piping system (a piping system consisting of a helical coil wrapped around another helical coil which is cylindrical) are described. The angular momentum equations are derived in general and the parametric equations for the double helix are given in a rectangular Cartesian coordinate system, x', y', z'. The components of angular momentum are calculated in this system about the origin. The angular momentum components are also calculated about the origin of another Cartesian coordinate system x, y, z. This permits calculation of the angular momentum components about any desired point in a given body. The program listing is included. (auth)

13361 (NAA-SR-Memo-9309) NAA PROGRAM DESCRIPTION. PERT-MAN—A PROGRAM FOR AUTOMATIC PLOTTING OF FORECASTED MANPOWER REQUIREMENTS FROM A PERT NETWORK. L. R. Blue and I. R. Friedman (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 1963. Contract AT-11-1-GEN-8. 87p.

The PERT-MAN program for automatic plotting of predicted manpower required to accomplish a PERT network plan is described. The program processes output data from PERT-AI NAP to produce automatic graphic displays, via the SC 4020, of manpower requirements as a function of time over the life of the PERT network. Flow charts and the program listing are included. (auth)

13362 (NYO-10433) NUMERICAL CALCULATIONS OF MULTIDIMENSIONAL SHOCKED FLOWS. Samuel Z. Burstein (New York Univ., New York. Atomic Energy Commission Computing and Applied Mathematics Center). Nov. 15, 1963. Contract AT(30-1)-1480. 67p.

Numerical methods are described for the calculation of two-dimensional time-dependent inviscid flows which contain shocks. The problems were considered to be time dependent and their solutions are found asymptotically for large values of time ($t \to \infty$). Results are given for oblique shock reflection and Mach reflection. The numerical scheme was tested for values of Mach numbers that ranged between $1.3 \leq M_\infty \leq 3.0$. The conservation equations describing such flows are integrated over a region which contains multiple shocks. Two of the difference methods described are high order accuracy schemes (the method of Lax and Wendroff) which closely approximate the jump conditions across discontinuities and gives the shock transition within three mesh widths. The initial value problems that were considered had initial data close to the asymptotic solution and data that were arbitrarily remote from the desired solution. The methods used were able to handle the severe transients encountered in all cases. In addition to the above methods two other difference analogs to the partial differential equations of motion were tested and compared. Numerical results are given for the oblique reflection and Mach reflection calculation. Comparison of the computed data with the exact solution of ordinary reflection is good. The behavior of the Mach reflection calculation seems to be qualitatively correct. (auth)

13363 (ORNL-3548) PURIFICATION OF DI(2-ETHYLHEXYL)PHOSPHORIC ACID. J. M. Schmitt and C. A. Blake, Jr. (Oak Ridge National Lab., Tenn.). Feb. 17, 1964. Contract W-7405-eng-26. 13p.

A procedure is described for the purification of di(2-ethylhexyl)phosphoric acid. Essential steps include acid hydrolysis, conversion to the sodium salt, extraction of the neutral impurities with petroleum ether, reconversion to the acid form, and extraction of the monoalkylphosphoric acids with ethylene glycol. Product, in batches of approximately 1200 g, has been obtained in greater than 99.8% purity, nearly free from monoalkylphosphoric acids, trialkylphosphates, alcohols, and complexed metals. The equipment size and reagent quantities may be scaled up or down conveniently. Di(2-ethylhexyl)phosphoric acid is available commercially as the acid itself or as a water solution of its sodium salt. Both forms may be treated successfully by this method. The procedure should be applied to purification of other similar dialkylphosphoric acids. (auth)

13364 (SC-4794(RR)) PREPARATION OF RESISTORS USING A LOW-TEMPERATURE-COEFFICIENT-OF-RESISTANCE ELECTROLYTE. R. D. Kelly (New Mexico. Univ., Albuquerque. Engineering Experiment Station). Jan. 1964. For Sandia Corp., Albuquerque, N. Mex. Contract AT(29-1)-789. 148p.

An electrolytic solution containing acid, sugar, salt, and distilled water (boric acid, mannitol, and potassium chloride) was experimentally tested to determine its suitability for use in preparing "water resistors" which exhibit a low temperature coefficient of resistance throughout the range from 40 to 160°F. The resistors use standard plastic containers provided with suitable end electrodes for containing the solutions. A scheme is presented for determining the amounts of the various electrolyte constituents to obtain any resistance value throughout the range from 10 to 100 K ohms. The resulting resistors exhibit excellent temperature characteristics from 60 to 160°F, and acceptable characteristics down to a temperature of 40°F. Considering 78°F as reference, a given resistance can be prepared to be within about 1 to 2% of a specified value at this temperature. A total change in resistance of about 2% is experienced throughout the temperature range from 60 to 160°F. The

short-term drift in resistance as the resistor is repeatedly cycled throughout the temperature range (40 to 160°F) is less than 5%. The resistors are thus suitable for voltage-divider use in high-voltage pulse circuits and for providing loads for high-voltage pulse transformers. The results of a few tests indicate that the long-term stability of these resistors may be poor. Additional work should be done to evaluate the long-term stability characteristics. (auth)

13365 (SC-4976(RR)) SUMMARY OF STAGNATION CHAMBER TEMPERATURE STUDIES IN THE SANDIA 5-INCH HYPERSONIC WIND TUNNEL. Raymond A. Mitchell and Kennith L. Goin (Sandia Lab., Albuquerque, N. Mex.). Feb. 1964. Contract [AT(29-1)-789]. 28p.

The total temperature variance with time and position in the stagnation chamber of the 5-inch hypersonic wind tunnel, experiments performed to find the origin of the temperature variance, and tests performed to determine the merit of several air mixers for the stagnation chamber are summarized. A conical orifice mixer was found to meet the performance requirements of reducing temperature gradients to less than 1% and eliminating the temperature fluctuations. (auth)

13366 (SC-DC-64-326) CIRCULATION PROCESSES AND MIXING MECHANISMS IN THE UPPER ATMOSPHERE ABOVE 30 KM. Quarterly Progress Report No. 1, September 15, 1963–December 15, 1963. (Geophysics Corp. of America, Bedford, Mass.). For Sandia Corp., Albuquerque, N. Mex. Contract AT(29-1)-789. 22p.

Terminal fall velocities in the ARDC model atmosphere (1959) between 30 and 70 km are calculated for smooth spherical particles with radii between 1 and 100 μ and densities of 5 and 2 gm/cm^3. The terminal velocities are based upon a Stokes drag force with a correction for slip flow. The total time of particle descent from 70 to 30 km was also calculated for 1, 5, and 10 μ particles. These descent times can be considered a zero order approximation to descent time for similar particles in the real atmosphere. (auth)

13367 (SC-DR-320-63) HEAT TRANSFER IN LIQUID HYDROCARBON FUEL FIRES. B. E. Bader (Sandia Lab., Albuquerque, N. Mex.). Feb. 1964. Contract AT(29-1)-789. 32p.

In recent years there has been an increased interest in the behavior of various items or systems exposed to fires resulting from accidents. The response of a system to an environment of this type is a function not only of the design of the system, but also of the physical condition of the item after the accident, its position relative to the fire, and the fire environment itself. This report concerns itself with a description of the fire environment, the development of an analytical fire "model," and the application of the model to any system under consideration. (auth)

13368 (SC-R-322) INFRARED SPECTROPHOTOMETRIC ANALYSIS OF URETHANE COMPOUNDS. H. L. Brumfield (Sandia Corp. Livermore Lab., Livermore, Calif.). Dec. 1963. Contract [AT(29-1)-789]. 69p.

Sandia Corp. Monograph.

A simple, quantitative analytical method is presented for determining the percent of a particular group or structure within a urethane compound by means of the infrared spectrophotometer. The overall objectives and results of this study are summarized and the advantages of this method are explained. (auth)

13369 (SC-TM-64-26) ENVIRONMENTAL SEALING OF CONNECTORS ON MILITARY CABLES. G. Voida (Sandia Lab., Albuquerque, N. Mex.). Feb. 1964. Contract [AT(29-1)-789]. 43p.

Described are the environmental overtests of military (pullout) cable assemblies which were back-sealed with polyurethan potting compound. Changes in shield braid resistance, conductor resistance, and insulation resistance were principal considerations. Detailed measurements were made before, during, and after the environmental testing to determine (1) shield braid resistance, (2) adhesion stability of the potting compound, (3) moisture tightness of the cable connectors, (4) environmental stability of the Loctite adhesive, (5) the locking stability of the connector assembly, and (6) the exposure stability of the chromate finish on aluminum parts. Upon completion of the environmental exposures, electrical measurements were taken of isolated segments of the cable assembly to determine the location of the high shield resistance. Postmortem examination of the sectioned connectors revealed (1) the adhesion and sealing stability of the polyurethan, (2) the filling qualities of the polyurethan, (3) corrosion susceptibility of the aluminum parts, (4) the penetrating (capillary action) qualities of the fluorescent dye-colored adhesive, (5) the condition of braid wire between the clamp plates, (6) the assembly workmanship, and (7) the reliability of radiographic inspection. (auth)

13370 (SC-TM-352-63(24)) REPORT ON COMARS—COORDINATE MEASURING AND RECORDING SYSTEM. D. R. Deatherage, G. P. McKenna, and S. D. Teisher (Sandia Lab., Albuquerque, N. Mex.). Jan. 1964. Contract AT(29-1)-789. 13p.

A system for digitally measuring and recording linear dimensions accurately to ±0.0001 in. is described. The system is rugged enough to be used in a normal factory environment. The results of an error-of-measurement study made on this system are also included. (auth)

13371 (SC-TM-354-63(72)) CLIMATOLOGICAL STUDY OF ATMOSPHERIC SOUNDINGS FOR TONOPAH TEST RANGE, NEVADA. R. F. Gentzler (Sandia Lab., Albuquerque, N. Mex.). Jan. 1964. Contract [AT(29-1)-789]. 24p.

All available atmospheric radiosonde observations taken at Tonopah Test Range, Tonopah, Nevada, for the period of February 1957 to May 1963, were reduced and summarized by months and by seasons. The soundings were taken on a nonscheduled basis, generally during daytime hours. Average values of temperature, pressure, density, and speed of sound vs altitude for standard pressure levels are presented. (auth)

13372 (SCL-TM-64-26) SANDIA HIGH-PRECISION AUTOMATIC PARTS ENGINEERING (SHAPE) COMPUTER PROGRAM. J. N. Rogers (Sandia Corp., Livermore Lab., Livermore, Calif.). Jan. 1964. Contract [AT(29-1)-789]. 54p.

The techniques of Sandia High-Precision Automatic Parts Engineering (SHAPE) are introduced. SHAPE is an IBM FORTRAN language computer program that facilitates the determination of the geometric quantities involved in specifying a contour. Currently, the program can be used to define contours based on points, straight lines, and circles. It has application in several areas such as numerical control, preparation of engineering drawings or specifications, and calculation of information required for inspection of parts. (auth)

13373 (TID-20155) OXIDATION AND REDUCTION STUDIES ON IRON–TITANIUM ALLOYS AND ON FERRIC OXIDE CONTAINING TITANIUM AND CALCIUM. End of Year Report. Gordon H. Geiger and J. Bruce Wagner, Jr. (Northwestern Univ., Evanston, Ill. Technological Inst.). Jan. 31, 1964. Contract AT(11-1)-1126. 151p.

The oxidation of Fe–Ti alloys to wüstite containing Ti and the reduction of hematite containing Ti and Ca to magnetite in $CO-CO_2$ mixtures were studied and the rates of these reactions were related to the electrical conductivities of wüstite and Ti- and Ca-doped hematite. The addition of Ti to Fe decreases the rate of oxidation to wüstite; this is interpreted to mean that the phase boundary reaction-controlled oxidation is influenced by the cation vacancies. The addition of Ti to hematite decreases the rate of reduction to magnetite, while Ca increases the rate; Ti probably increases the Fermi level or chemical potential of the electrons in the oxide, while Ca decreases it, thereby changing the reduction rate. The addition of Ti to wüstite decreases the electrical conductivity, and both pure and Ti-doped wüstite show complete dissociation of holes and vacancies above 1000°C and incomplete dissociation below 1000°C. A p-to-n transition occurs in wüstite at high temperatures and high vacancy concentrations. The addition of Ti to hematite increases the electrical conductivity, but it remains n-type, while Ca both increases the conductivity and changes it to p-type. (D.L.C.)

13374 (TID-20160) MECHANISMS OF ION UPTAKE BY THE LEAVES OF PHASEOLUS VULGARIS L. (thesis). Woon Heng Jyung (Michigan State Univ., East Lansing). 1963. Contract AT(11-1)-888. 100p.

Mechanisms of foliar absorption of phosphate and Rb in bean leaves (Phaseolus vulgaris L.) were investigated by means of a newly developed leaf immersion and washing technique, by specific absorption studies, and by utilizing criteria for active uptake, i.e., time course analysis, temperature, oxygen, and energy dependence, sensitivity to metabolic inhibitors, accumulation against a concentration gradient, irreversibility, and pH response. Classic enzyme kinetics were employed in studying uptake of phosphate and Rb by bean leaves. One of the primary leaves of a bean plant was treated by immersion into a solution to a depth of 0.5 cm with the aid of proper glass rod frames. Treating solutions consisted of 2 μC P^{32}/13.3 μ moles H_3PO_4 in 40 ml for phosphate, and 0.4 μC Rb^{86}/40 μ moles RbCl in 40 ml for Rb. Results are reported for experiments performed under continuous illumination and for light-dark experiments. (C.H.)

13375 (TID-20172) A MACHINE FOR PRODUCING SQUARE TORSION PULSES OF MICROSECOND DURATION. Technical Report No. 1. D. P. Pope, T. Vreeland, Jr., and D. S. Wood (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). Jan. 1964. Contract AT(04-3)-473. 24p.

A dynamic torsion testing machine was built for the purpose of applying a known constant shear stress to a ½ in. diameter cylindrical test specimen for very short periods of time. The shear stress at the surface of the specimen rises from zero to any desired value in the range 0 to 3000 psi, within a period of 4 to 6 microsec. The time at constant stress varies linearly with axial position from the free end of the specimen ranging from 0 to about 500 microsec. The stress is removed within a period of 4 to 6 microsec and for short specimens it remains essentially zero thereafter. This machine was developed for the measurement of dislocation velocities up to 10^4 in./sec in metal single crystals. (auth)

13376 (TID-20175) THE KINETICS OF THE ELECTRON EXCHANGE BETWEEN THE 12-TUNGSTOCOBALTATE(II) AND THE 12-TUNGSTOCOBALTATE(III) ANIONS IN AQUEOUS SOLUTION. Paul G. Rasmussen and Carl H. Brubaker, Jr. (Michigan State Univ., East Lansing. Kedzie Chemical Lab.). [1963]. Contract AT(11-1)-1001. 15p.

The kinetics of the electron exchange between the 12-tungstocobaltate(II) and 12-tungstocobaltate(III) anions was studied at 0° in aqueous solution. Precipitation of the $[Co(III)O_4W_{12}O_{36}]^{6-}$ with $(Bu)_4NI$ was used for separation. The reaction is first order in each ion, and the effects on the rate of changes in the hydrogen ion concentration, ionic strength, temperature, cations, and dielectric constant are described. At 0° and ionic strength of 0.6 M (adjusted with LiCl) the rate constant is 0.63 ± 0.016 M^{-1} sec^{-1}. An "outer-sphere" mechanism is postulated for the system and the results are compared with the theoretical predictions of R. A. Marcus. (auth)

13377 (TID-20184) MECHANISMS OF ION UPTAKE BY LEAVES OF HIGHER PLANTS AS REVEALED BY RADIOISOTOPES. S. H. Wittwer, Y. Yamada, W. H. Jyung, and M. J. Bukovac (Michigan State Univ., East Lansing). [1964]. Contract AT(11-1)-888. 5p.

Mechanisms involved in the uptake of nutrients by plant leaves are reviewed. Applications of radioisotopes as tracers in agricultural studies of foliar feeding are discussed. Results are summarized from studies on the mechanisms and kinetics of ion uptake by intact leaves, the binding of ions on cuticular leaf surfaces, the penetration of cuticular membranes by ions, and ion uptake by isolated cells of the leaf. Data are included on the foliar absorption of phosphate, sulfate, Rb, Ca, and Cl by the leaves of bean, tomato, onion, and tobacco plants. (C.H.)

13378 (TID-20186) ION BINDING BY SURFACES OF ISOLATED CUTICULAR MEMBRANES. Y. Yamada, M. J. Bukovac, and S. H. Wittwer (Michigan State Univ., East Lansing). [1964]. Contract AT(11-1)-888. 13p.

A markedly greater binding of Ca^{2+} from $Ca^{45}Cl_2$ and SO_4^{2-} from $K_2S^{35}O_4$ occurred on the inner compared to the outer surfaces of enzymically isolated cuticular membranes of astomatous ripe tomato fruit cuticles and stomatous green onion leaf cuticles. This was related morphologically to smooth outer cuticular surfaces compared with an inner surface showing an irregular network of protrusions and cuticular fragments on the tomato, and impressions of cell walls and guard cells on the onion. Retention of ions, on comparable cuticular surfaces, against blotting, washing, and exchange was greater for Ca^{2+} than SO_4^{2-}, and for onion leaf than tomato fruit. Total removal for SO_4^{2-} but not for Ca^{2+} was accomplished by exchange. Maximum fixation of Ca^{2+} on surfaces of tomato fruit cuticle occurred within three minutes from a concentration of 1 mM $CaCl_2$. Saturation with SO_4^{2-} was not achieved even after 200 minutes. Ion binding on fresh but not on boiled cuticular surfaces of tomato fruit, or a dialyzing membrane, was enhanced by KCN and kinetin, but greatly reduced by 2,4-dinitrophenol. (auth)

13379 (TID-20189) EFFECT OF CALCIUM LEVEL AND PLACEMENT IN THE SOIL ON ITS UPTAKE BY PLANTS AND ON THE SOURCE OF THE CALCIUM TAKEN UP BY PLANTS. Final Report. John L. Ragland (Kentucky. Univ., Lexington. Kentucky Research Foundation). Dec. 1963. Contract AT(40-1)-2629. 50p.

Preliminary results are reported from studies on the uptake of Ca from soil by pasture plants and the effect of the lime content in the soil on Ca uptake. Data are presented from studies of Ca uptake by bluegrass. Calcium-45 was used as a tracer. (C.H.)

13380 (USNRDL-TR-212) COMPILATION OF CRATER DATA FROM SURFACE AND UNDERGROUND EX-

PLOSIONS. R. Shnider (Naval Radiological Defense Lab., San Francisco). Mar. 5, 1958. 18p.

Presented is a compilation of the measurements of parameters of craters resulting from surface and underground detonations. The sources for the data, in most cases the experimental group responsible for the tests, are included. (auth)

13381 (VDIT-84) LITERATURE SURVEYS AND BIBLIOGRAPHIES PREPARED DURING THE PERIOD FROM JANUARY 1962 THROUGH DECEMBER 1963. A Bibliography of Bibliographies. W. Uhlmann (Aktiebolaget Atomenergi, Stockholm). 15p.

Bibliographic data and short indicative abstracts are presented of 31 literature surveys and bibliographies which were prepared by the Information Office, Scientific and Technical Information, of Ab Atomenergi. The references are arranged according to biology and medicine; chemistry; geology, mineralogy, and meteorology; health and safety; instruments and instrumentation; metals, ceramics, and other materials; physics; and reactor technology. (D.L.C.)

13382 (WAPD-TM-402) TSRV3—A SYMBOLIC TAPE SERVICE PROGRAM FOR THE PHILCO-2000 COMPUTER. R. L. Elder and O. F. Swift (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Aug. 1963. Contract AT(11-1)-Gen-14. 35p.

The program TSRV3, which facilitates storage and maintenance of symbolic card programs on magnetic tape, is described. The stored programs may be updated, compiled, sequence numbered, punched, reordered, or edited by appropriate control instructions to TSRV3. (auth)

13383 (AEC-tr-6325) LORENTZ-TRANSFORMATION OF HEAT AND TEMPERATURE. H. Ott. Translated for Los Alamos Scientific Lab., N. Mex., from Z. Physik, 175: 70-104(1963). 36p.

Errors in the usual derivation of the transformation are examined, together with the implications and validity of the proper derivation. (D.C.W.)

13384 (AEC-tr-6330) PROPOSITION OF AN EMPIRICAL FORMULA FOR THE CHIMNEY PLUME RISE IN ADDITION TO AN EXAMINATION OF KNOWN FORMULAE WITH SUPPLEMENTARY OBSERVATION DATA. H. Stuemke. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from a paper presented to the II Committee of the VDI-Board for the "Maintenance of Air Purity." Feb. 1963. 31p.

After a literature survey on recent publications dealing with the problem of the chimney plume rise, the formulas by Holland and by Lucas-Moore-Spurr were evaluated on the basis of experimental data available. It was found that these formulas are not suitable for a correct representation of experimental facts, and that in certain cases they fail completely. Hence, a four-parametric formula was chosen as a starting point for this presentation, which constitutes a generalization of the formulas by Holland and Lucas-Moore-Spurr, and which for the case of cold chimney gases reduces to the impulse term determined experimentally by A. F. Rupp by his studies on wind-tunnels. The four free parameters were chosen on the basis of systematic calculations in such a way that the resulting formula interprets the entire available experimental material consisting of five collectives in a most precise manner. The structure of this formula points to the fact that the muzzle velocity probably has a less significant influence upon the chimney plume rise of hot smoke gases than could be expected from the two formulas used as a reference. (auth)

13385 (AI-Trans-35) THE ELECTRONIC STRUCTURE AND MAGNETIC PROPERTIES OF TRANSITION METALS AND ALLOYS. J. Friedel. Translated by Anthony Cornell (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.), from J. Phys. Radium, 23: 501-10(1962). 22p.

The present knowledge about the electronic structure of the transition metals is briefly discussed. The nature of the perturbations produced by impurity atoms is deducted. General conclusions are obtained concerning the possible existence, in pure transition metals, of permanent magnetic moments, their localization, and their couplings. (auth)

13386 (AI-Trans-36) MEASUREMENT OF THE DISPLACEMENT ENERGY OF A LATTICE ATOM IN $A^{III}B^{V}$-COMPOUNDS BY ELECTRON COLLISION. R. Baeuerlein. Translated by Anthony Cornell (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.), from Z. Physik, 176: 498-509(1963). 16p.

Measurements of the displacement energies are reported for the following $A^{III}B^{V}$-type compounds: GaAs, InP, InAs, and InSb. The results are compared with these for $A^{II}B^{VI}$ compounds (ZnSe and CdS) and semiconductor elements (Si and Ge). The physical processes taking place during the displacement of a lattice atom through collision with a fast particle are discussed. (D.L.C.)

13387 ANNUAL REPORT TO CONGRESS OF THE ATOMIC ENERGY COMMISSION FOR 1963. (Atomic Energy Commission, Washington, D. C.). Jan. 1964. 529p. (GPO)

The 1963 programs were reviewed under the headings: nuclear materials, raw materials, production, military applications, civilian power, SNAP, N.S. Savannah, military reactors, nuclear safety, operational safety, radioactive waste management, radioisotopes development, Plowshare Program, international affairs, international conferences and exhibits, biology and medicine, physical research, education and training, industrial participation, industrial relations, contracting policy, classification and declassification, public information, technical information, patent matters, nuclear materials management, and regulatory activities. (C.E.S.)

13388 ATOMIC ENERGY ENCYCLOPEDIA IN THE LIFE SCIENCES. Charles Wesley Shilling (Division of Biology and Medicine, AEC). 474p. Philadelphia, W. B. Saunders Company, 1964. $10.50.

The features of both a dictionary and an encyclopedia are combined to present information on the effects of radiation on living material and the uses of radiation and radioactive isotopes in medicine, agriculture, and biology. Physical concepts of importance in radiobiology and information on each of the elements are included. The problems of health protection, environmental contamination, waste disposal, and weapons testing are covered briefly. Descriptions of representative accelerators, reactors, radiation detectors, and relevant instruments are included. Plants and laboratories in the United States doing work in the field of atomic energy are listed. This encyclopedia should be useful to high school and college students, physicians, and research scientists. (C.H.)

CORPORATE AUTHOR INDEX

This index contains entries for this period for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

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ä	becomes	ae
ö		oe
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SUBJECT INDEX

Main entries in this index are generally specific materials, things, and processes. These are followed by modifiers that describe the properties of, and processes applied to, the main entries.

The number preceding the colon is the *NSA* volume number, and the number following is the abstract number. The designation (R) following the abstract number indicates that the abstract is of a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. References to report numbers, where appropriate, are included after the abstract number of the citation. Published literature (journal article or book) is identifiable by the absence of a report number.

General Indexing Style

The user should bear in mind that the ideas presented in the original literature, rather than key words, have been indexed. The indexers have tried to select what seemed the most probable and logical place to look for typical information. Since it is not possible to anticipate where a user would look for information, numerous cross references are included to assist him in his search.

Experience in using an index of this type will be the best guide in obtaining the desired information, and a consideration of synonymous or closely related terms will prove valuable.

Information must be so indexed as to be of the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use, nor to the general class headings that include the specific headings. For example, information on the treatment of thyroid disease with I-131 would be indexed under Thyroid Diseases and under Iodine Isotopes I-131, but not necessarily under Radiotherapy. A study of the effects of x radiation on hair would be indexed under both X Radiation and Hair. However, the information would not be indexed under the experimental animal, e.g., Rats, unless the report discusses the effects on rat hair as compared with the effect on the hair of other animals.

The broad, general class headings are used only for general information or for comprehensive reports or articles.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings or, in some cases, subheadings; e.g., Amino Acids rather than Acids, amino; Helium Isotopes He-4 rather than Helium—isotopes He-4 or Helium—He-4 isotopes. Note, however, that in some cases modifying terms are used parenthetically in preference to a more direct type of entry which would result in the scattering of information. Organic compounds, however, are usually entered in the index in the inverted form so that substituted compounds can be listed near the parent compound; e.g., Benzene, Bromo- rather than Bromobenzene. In general, the style of nomenclature used is that of *Chemical Abstracts*, except that some items listed in that publication as subheadings are elevated to form part of the main heading; e.g., Butyric Acid, Methyl Ester rather than Butyric Acid—methyl ester.

Alphabetization

Main headings are arranged according to the widely accepted word-by-word alphabetic system. A parenthetic qualifier following a main heading is disregarded in alphabetizing unless there are two or more headings identical except for the parenthetic qualifier, in which case the qualifier determines the order. Headings involving Greek letters are arranged as if the names of the letters were spelled out, e.g., Mesons (π), Mesons (ξ).

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed in the direct form, listing cations in the order of increasing valence in the case of polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., Sodium Aluminum Silicates and Potassium Sodium Sulfates.

Multicomponent Systems

Multicomponent alloys, except well-known trade names are indexed under each element in the alloy.

Example: Aluminum–Chromium Alloys are indexed

ALUMINUM ALLOYS
Al–Cr ...
CHROMIUM ALLOYS
Al–Cr ...

Well-known alloys such as Hastelloy are indexed directly with cross references under the element components. Multicomponent systems of elements are indexed similarly.

Example: Silicon–Tungsten Systems are indexed

SILICON SYSTEMS
Si–W ...
TUNGSTEN SYSTEMS
Si–W ...

Multicomponent systems of compounds are similarly indexed under the compound.

Physical States of Materials

In this subject index specification of the physical state of the material, if other than normal, is included in the modifying phrase.

Modifying Phrases (Subheadings)

Descriptive phrases (modifiers), rather than ordinary subheadings, are used under the main headings to give a better indication of the material covered in an abstract than would be possible with only a word or two whenever it appears that such information would be useful. Such phrases are written so that the idea considered most important is presented first, should a not-too-awkward expression result. However, when using this index, the reader is advised to scan all modifiers under a main heading to determine whether any abstracts in addition to the most obvious should be consulted for the desired information. Many of the modifiers are designed to be read in inverted order or to be read with the main heading inserted at the position of the comma in order to obtain a meaningful phrase; e.g., Uranium—allotropic transformation temperatures of, effect of cooling rate on is read "effect of cooling rate on allotropic transformation temperatures of uranium." In many cases, the prepositions have been omitted from such phrases provided no ambiguity results from the omission.

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416239	18-12998	See SSD-TDR-63-204
416490	18-12328	$2.60(OTS)
418559	18-13237	See GNE-Phys/63-12
418563	18-12415	See GNE/Phys/63-14
418989	18-12414	See GA/Phys/63-4
419313	18-13314	See GA/Phys/63-2
425547	18-12629	See DMIC-191
426732	18-12537	$6.60(OTS)
427205	18-12030	$1.10(OTS)
427665	18-13143	See SSD-TDR-63-338
427755	18-11654	See USNRDL-TR-693
427997	18-12594	$9.60(OTS)
428441	18-12153	See USNRDL-TR-699
429144	18-12595	$3.60(OTS)
429298	18-12260	See USNRDL-TR-704
429407	18-12729	See REIC-ACCESS-71
430751	18-13336	See NRL-Memo-1481
AE–	(Non-AEC)	
129	18-13026	Dep.(mc)
130	18-12718	Dep.(mc)
AEC-tr–		
6304	18-11975	Dep.(mc); $1.10(fs), $0.80(mf) JCL
6312	18-12603	Dep.(mc); $3.60(fs), $0.86(mf) JCL
6325	18-13383	Dep.(mc); $3.60(fs), $1.28(mf) JCL
6326	18-13198	Dep.(mc); $6.60(fs), $2.06(mf) JCL
6328	18-12583	Dep.(mc); $2.60(fs), $1.10(mf) JCL,
6330	18-13384	Dep.(mc); $3.60(fs), $1.13(mf) JCL
6331	18-11576	Dep.(mc); $2.60(fs), $1.01(mf) JCL
6336	18-13303	Dep.(mc); $2.60(fs), $0.89(mf) JCL
AECL–	(Canadian)	
1849	18-13074	Can. J. Phys., 42: 153-63(1964)
1869	18-13076	Can. J. Phys., 42: 218-20(1964)
1872	18-12454	See CRRD-1172
1882	18-13277	Dep.
AEET-ANAL–	(Indian)	
18	18-12411	Dep.(mc)
28	18-11961	Dep.(mc)
AEET-CD–	(Indian)	
16	18-12121	Dep.(mc)
18	18-12031	Dep.(mc)
19	18-12887	Dep.(mc)
AEEW-R–	(British)	
254	18-13039	Dep.(mc)
AERE-M–	(British)	
913	18-12122	Dep.; $0.30(BIS); 1s. 9d. (HMSO)
1321	18-12311	Dep.; $0.50(BIS); 2s. 6d. (HMSO)
AERE-R–	(British)	
4485	18-12384	Dep.; $0.30(BIS); 1s. 9d. (HMSO)
AFCRL–	(Non-AEC)	
63-127	18-13128	$6.60(OTS)
63-452	18-12855	$1.60(OTS)
63-607	18-12856	$10.10(OTS)
63-672	18-12763	$3.60(OTS)
63-681	18-12841	$3.60(OTS)
63-753	18-12412	OTS

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AFOSR–	**(Misc.)**	
4644	18-13129	
4742	18-12888	$5.60(OTS)
AFSWC-TDR–	**(Non-AEC)**	
62-144	18-13312	$8.10(OTS)
63-17	18-12621	See ARF-A6003
AGN-TM–		
405	18-13278	Dep.; $1.50(OTS)
AGN-TP–		
52	18-12610	See CONF-373-3
66	18-13245	Dep.(mc); $2.60(fs), $1.07(mf) OTS; Gmelin, AED-CONF-63-225-9
AHSB(S)–	**(British)**	
R-60	18-13027	Dep.; $0.70(BIS); 3s. 6d. (HMSO)
Al-Trans–		
35	18-13385	Dep.(mc); $2.60(fs), $0.86(mf) JCL
36	18-13386	Dep.(mc); $1.60(fs), $0.80(mf) JCL
AID-P–	**(Non-AEC)**	
63-53	18-13328	$3.60(OTS)
63-60	18-13329	$1.60(OTS)
63-88	18-13330	$2.60(OTS)
AN–	**(Misc.)**	
973	18-12852	See AD-409570
ANL–		
6773	18-13279	Dep.; $1.50(OTS)
6794	18-12761	Dep.; $2.75(OTS)
6803	18-12032	Dep.; $0.50(OTS)
APED–	**(Misc.)**	
4364	18-12574	
ARA-T–	**(Non-AEC)**	
9197-7	18-13130	
ARF–	**(Misc.)**	
A6003	18-12621	$8.60(OTS)
B201-27	18-12538	$3.60(OTS)
AROD–	**(Misc.)**	
1428:9	18-11957	Dep.(mc); $1.10(fs), $0.80(mf) OTS
ASD-TDR–	**(Non-AEC)**	
62-354(Pt.II)	18-12622	$5.60(OTS)
62-475	18-12280	$2.50(OTS)
63-204	18-12623	$1.25(OTS)
63-270(Pt.IV)	18-12624	
63-842	18-12312	
ASD-TR–	**(Non-AEC)**	
61-446(Pt.II)	18-12538	See ARF-B201-27
ATN–	**(Non-AEC)**	
64(9236)-3	18-12033	
AWRE-NR–	**(British)**	
5/63	18-13028	Dep.(mc)
AWRE-O–	**(British)**	
97/63	18-12625	Dep.(mc)
BAW–	**(Misc.)**	
207	18-13232	
1264	18-13313	Dep.(mc); $2.60(fs), $1.10(mf) OTS
1288	18-13185	Dep.(mc); $8.60(fs), $2.66(mf) OTS
BM-RI–	**(Misc.)**	
6341	18-12539	Dep.(mc); $3.60(fs), $1.31(mf) OTS
6373	18-12502	(Free) Bureau of Mines
6375	18-12626	Free (Bureau of Mines)
6381	18-12253	Free (Bureau of Mines)
6382	18-12138	Free (Bureau of Mines)
BMI–	**(Misc.)**	
1657(Del.)	18-13354	Dep.; $1.75(OTS)
BNL–		
823	18-12281	Dep.; $2.25(OTS)
7227	18-12064	J. Chem. Phys., 40: 402-4(1964)
7314	18-12065	J. Chem. Phys., 40: 504-15(1964)
7356	18-12944	Phys. Rev., 133: B1276-89(1964)
7377	18-12941	Phys. Rev., 133: B1257-66(1964)
7392	18-12940	Phys. Rev., 133: B1239-57(1964)
7428	18-12074	J. Chem. Phys., 40: 860-6(1964)
7473	18-12939	Phys. Rev., 133: B1224-31(1964)
7656	18-12445	Dep.(mc); $2.60(fs), $0.86(mf) OTS; Gmelin, AED-CONF-63-007-109
7768	18-12446	Dep.(mc); $1.10(fs), $0.80(mf) OTS
7769	18-12447	Dep.(mc); $1.10(fs), $0.80(mf) OTS
CAPE–		
541	18-12297	EM
955	18-13343	EM
980	18-12330	EM
981	18-12331	EM
1067	18-12332	EM
1069	18-12298	EM
1073	18-12299	EM
1082	18-12300	EM
1083	18-12301	EM
1087	18-12302	EM
CEA–	**(French)**	
2325	18-13280	Dep.(mc)
CEAL–		
1007	18-13174	Dep.(mc); $1.10(fs), $0.80(mf) OTS
1008	18-12798	Dep.(mc); $1.60(fs), $0.80(mf) OTS
CERN–	**(European Organization for Nuclear Research)**	
63-35	18-12799	Dep.(mc)
63-37	18-12889	Dep.(mc)
CNAEM–	**(Turkish)**	
12	18-13041	Dep.(mc)
CNLM–	**(Non-AEC)**	
5205	18-12292	
CONF-22–	**(American Physical Society, 1963 Annual Meeting, New York, Jan. 1963)**	
30	18-13042	Dep.(mc); $5.60(fs), $1.76(mf) OTS; Gmelin, AED-CONF-63-007-108
31	18-12445	See BNL-7656
CONF-24–	**(4th Symposium [on] Engineering Aspects of Magnetohydrodynamics, Berkeley, Calif., Apr. 1963)**	
21	18-13171	ORINS. Gmelin, AED-CONF-63-030-23
CONF-81–	**(Conference on Basic Mechanisms in the Radiation Chemistry of Aqueous Media, Gatlinburg, Tenn., May 1963)**	
5	18-11627	Dep.(mc); $3.60(fs), $1.19(mf) OTS; Gmelin, AED-CONF-63-075-5

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CONF-110–	**(American Institute of Chemical Engineers 56th Annual Meeting, 1963 Annual Meeting, Houston, Tex., Dec. 1963)**	
2	18-12333	ORINS. Gmelin, AED-CONF-63-249-1
3	18-12517	ORINS. Gmelin, AED-CONF-63-249-2
CONF-133–	**(International Atomic Energy Agency Symposium of Exponential and Critical Experiments with Calculations, Amsterdam, Sept. 1963)**	
38	18-13236	See EIR-57
CONF-166–	**(American Society for Testing Materials 66th Annual Meeting, Atlantic City, June 1963)**	
12	18-12758	ORINS. Gmelin, AED-CONF-63-098-13
CONF-174–	**(12th Annual Conference, Application of X-ray Analysis, Denver, Aug. 1963)**	
9	18-12113	ORINS. Gmelin, AED-CONF-63-123-25
CONF-185–	**(Institute of Environmental Sciences Meeting, Los Angeles, Apr. 1963)**	
2	18-12793	p.45-6 of "Institute of Environmental Sciences, 1963 Annual Technical Meeting Proceedings." Mt. Prospect, Ill., Institute of Environmental Sciences, 1963
CONF-187–	**18-381**	**(American Nuclear Society Meeting, New York, Nov. 1963)**
34	18-13245	See AGN-TP-66
35	18-13234	Dep.(nc); $1.10(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-225-10
37	18-13281	Dep.(nc); $2.60(fs), $0.89(mf) OTS; Gmelin, AED-CONF-63-225-1
38	18-12881	ORINS. Gmelin, AED-CONF-63-225-4
39	18-12880	ORINS. Gmelin, AED-CONF-63-225-5
41	18-12322	ORINS. Gmelin, AED-CONF-63-225-7
42	18-13308	ORINS. Gmelin, AED-CONF-63-225-8
44	18-13307	ORINS. Gmelin, AED-CONF-63-225-13
45	18-13327	ORINS. Gmelin, AED-CONF-63-225-14
53	18-12725	See HW-SA-3127
54	18-12413	Dep.(nc); $1.10(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-225-66
56	18-13235	Dep.(nc); $2.60(fs), $1.07(mf) OTS; Gmelin, AED-CONF-63-225-16
61	18-12479	ORINS. Gmelin, AED-CONF-63-225-34
62	18-13306	ORINS. Gmelin, AED-CONF-63-225-35
63	18-12589	ORINS. Gmelin, AED-CONF-63-225-73
65	18-13265	ORINS. Gmelin, AED-CONF-63-225-64
66	18-12756	ORINS. Gmelin, AED-CONF-63-225-58
67	18-13038	ORINS. Gmelin, AED-CONF-63-225-59
72	18-12313	Dep.(nc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-225-25
74	18-13282	Dep.(nc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-225-27
75	18-12140	Dep.(nc); $1.10(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-225-28
78	18-12321	ORINS. Gmelin, AED-CONF-63-225-33
84	18-12596	Dep.(nc); $5.60(fs), $1.94(mf) OTS; Gmelin, AED-CONF-63-225-37
95	18-13186	Dep.(nc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-225-49
97	18-12719	Dep.(nc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-225-42
CONF-209–	**(American Vacuum Society Meeting, Boston, Oct. 1963)**	
22	18-12429	ORINS. AED-CONF-63-161-46
CONF-228–	**(International Association of Geomagnetism and Aeronomy 13th General Assembly of the International Union of Geodesy and Geophysics, Berkeley, Calif., Aug. 1963)**	
2	18-13006	ORINS. Gmelin, AED-CONF-63-250-1
CONF-243–	**(American Nuclear Society Conference on Problems of Operating Research and Power Reactors, Ottawa, Oct. 1963)**	
47	18-13196	Dep.(nc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-168-50
CONF-252–	**(2nd Caribbean Chemical Symposium, Rico Piedras, Puerto Rico, Aug. 1963)**	
4	18-12145	See PRNC-14
CONF-277–	**(Symposium on Radiation Emergencies in Medicine, Research, and Industry, Chicago, Dec. 1963)**	
3	18-12405	ORINS. Gmelin, AED-CONF-63-257-5
CONF-301–	**(International Conference on the Science of Superconductivity, Hamilton, New York, Aug. 1963)**	
27	18-13025	ORINS. AED-CONF-63-148-28
CONF-310–	**(Symposium on Physics and Nondestructive Testing, San Antonio, Oct. 1963)**	
4	18-12326	ORINS. Gmelin, AED-CONF-63-150-5
CONF-313–	**(2nd National Meeting of the Society for Applied Spectroscopy, San Diego, Calif., Oct. 1963)**	
8	18-12028	ORINS. Gmelin, AED-CONF-63-175-19
CONF-327–	**(Topical Conference on Compounds Nuclear States, Gatlinburg, Tenn., Oct. 1963)**	
13	18-12992	ORINS. Gmelin, AED-CONF-63-162-18
CONF-331–	**(The Metallurgical Society of American Institute of Mechanical Engineers Annual Meeting, Dallas, Feb. 1963)**	
3	18-12794	ORINS. Gmelin, AED-CONF-63-029-5
CONF-332–	**(Symposium on Noise Analysis in Nuclear Systems, Gainesville, Fla., Nov. 1963)**	
10	18-13193	ORINS. Gmelin, AED-CONF-63-215-12
11	18-12430	ORINS. Gmelin, AED-CONF-63-215-11
CONF-334–	**(Conference on Breeding Economics and Safety in Large Fast Power Reactors, Argonne, Ill., Oct. 1963)**	
23	18-13309	ORINS. Gmelin, AED-CONF-63-171-17
CONF-340–	**(American Physical Society 1963 Autumn Meeting, Chicago, Oct. 1963)**	
14	18-12628	Dep.(nc); $1.10(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-169-19
15	18-12453	Dep.(nc); $4.60(fs), $1.46(mf) OTS; Gmelin, AED-CONF-63-169-16
CONF-355–	**(Symposium in Medicine, Dynamic Clinical Studies with Radioisotopes, Oak Ridge, Tenn., Oct. 1963)**	
3	18-11622	ORINS. Gmelin, AED-CONF-63-200-6
CONF-356–	**(1963 American Society of Metals/Metals and Materials Show, Cleveland, Oct. 1963)**	
8	18-12327	ORINS. Gmelin, AED-CONF-63-223-4
9	18-12561	See UCRL-11009
CONF-363–	**(International Symposium on Plasma Phenomena, San Diego, Calif., Oct. 1963)**	
15	18-13266	ORINS. Gmelin, AED-CONF-63-202-14
CONF-373–	**(Technical Conference on Applied Aspects of Refractory Metals, Los Angeles, Dec. 1963)**	
3	18-12610	ORINS. Gmelin, AED-CONF-63-252-2

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CONF-375–		**(6th National Symposium Society for Aerospace Material Process Engineers, Seattle, Nov. 1963)**
6	18-12757	ORINS. Gmelin, AED-CONF-63-224-5
CONF-378–		**(43rd Annual Meeting, Highway Research Board, Washington, D. C., Jan. 1964)**
1	18-12287	See UCRL-7632(p.1-5)
2	18-12288	See UCRL-7632(p.6-10)
3	18-12289	See UCRL-7632(p.11-16)
4	18-12290	See UCRL-7632(p.17-20)
5	18-12291	See UCRL-7632(p.21-4)
CONF-385–		**(IUPAC Symposium on Thermodynamics and Thermochemistry, Lund, Sweden, July 1963)**
1	18-12034	Dep.(mc); $8.10(fs), $2.75(mf) OTS
CRRD–	**(Canadian)**	
1172	18-12454	Dep.; $0.20(AECL)
D–	**(Misc.)**	
2-4643-2	18-13029	
2-90037-9	18-12720	
2-90241	18-12721	$3.60(OTS)
DASA–	**(Misc.)**	
1357(Vol.IV)	18-12334	
DLCS–		
5001263	18-13283	Dep.(mc); $4.60(fs), $1.64(mf) OTS
DMIC–	**(Non-AEC)**	
191	18-12629	$2.75(OTS)
DP–		
801	18-13331	Dep.; $0.75(OTS)
856	18-12455	Dep.; $0.50(OTS)
DRP/ML–		
FAR R/100	18-13198	For translation see AEC-tr-6326
DS–	**(Non-AEC)**	
106	18-12630	$4.60(OTS)
127	18-12631	$6.60(OTS)
DUBNA REPORTS	**(Russian)**	
See JINR (Russian)		
EFINS–	**(Misc.)**	
63-67	18-12897	Dep.(mc); $3.60(fs), $1.16(mf) OTS
63-72	18-12898	Dep.(mc); $3.60(fs), $1.19(mf) OTS
EGCR-STUDY–		
II-469-1	18-13276	See ACNP-63625
II-650-1	18-13293	See TID-20131
EIR–	**(Swiss)**	
56	18-13344	Dep.(mc)
57	18-13236	Dep.(mc)
59	18-12456	Dep.(mc)
EOS–	**(Non-AEC)**	
3410(Final)	18-12860	See NP-13591
ER–	**(Misc.)**	
5453	18-12859	See NP-13516
ESD-TDR–	**(Non-AEC)**	
63-231	18-13175	$3.60(OTS)
EUR–	**(European Atomic Energy Community)**	
491.e	18-12457	Dep.(mc)
EURAEC–		
192	18-12563	Dep.(mc); $3.60(fs), $1.16(mf) OTS
493	18-12540	Dep.(mc); $1.60(fs), $0.80(mf) OTS
542	18-12722	Dep.(mc); $1.60(fs), $0.80(mf) OTS
594	18-12541	See GEAP-4089(Vols. I and II)
943	18-12542	See GEAP-4484
956	18-12310	See ACNP-64002
958	18-12651	See NCSC-2663-15
959	18-13187	Dep.(mc); $7.60(fs), $2.57(mf) OTS
FTD-TT–	**(Non-AEC)**	
63-344	18-12604	OTS
FZK–	**(Non-AEC)**	
9-183-2	18-13177	See NARF-62-16T
GA–	**(Misc.)**	
4434	18-13030	Dep.; $2.00(OTS)
4436	18-13031	
4490(Rev.)	18-13043	Dep.(mc); $3.60(fs), $1.28(mf) OTS
4688	18-13266	See CONF-363-15
GA-Phys.–	**(Non-AEC)**	
63-2	18-13314	$7.60(OTS)
63-4	18-12414	$8.60(OTS)
GEAP–	**(Misc.)**	
3726(Vol.3)	18-12575	Dep.; $3.00(OTS)
3824	18-13246	Dep.; $0.75(OTS)
4089(Vols.I&II)	18-12541	Dep.; $7.50(OTS)
4271	18-11962	Dep.; $0.75(OTS)
4294	18-12597	Dep.; $0.75(OTS)
4386	18-12458	Dep.(mc); $10.50(fs), $4.34(mf) OTS
4484	18-12542	Dep.(mc); $5.60(fs), $1.79(mf) OTS
GEMP–		
31A	18-12543	Dep.; $0.75(OTS)
231	18-13315	Dep.; $3.50(OTS)
GESR–		
2017	18-12857	Dep.(mc); $5.60(fs), $1.97(mf) OTS
GNE-Phys.–	**(Non-AEC)**	
63-12	18-13237	$9.10(OTS)
63-14	18-12415	$8.60(OTS)
HW–		
53368(Suppl.1)	18-11963	Dep.; $0.75(OTS)
68655	18-12254	Dep.(mc); $1.10(fs), $0.80(mf) OTS
70178(Rev.)	18-13247	Dep.; $1.00(OTS)
74204	18-12544	Dep.(mc); $1.10(fs), $0.80(mf) OTS
74204(Rev.1)	18-12545	Dep.(mc); $1.10(fs), $0.80(mf) OTS
76303	18-12546	Dep.; $2.50(OTS)
76566(Rev.1)	18-12548	Dep.(mc); $1.10(fs), $0.80(mf) OTS
77907	18-13284	Dep.(mc); $2.60(fs), $1.10(mf) OTS
78186	18-12581	Dep.(mc); $7.60(fs), $2.48(mf) OTS
78268	18-12459	Dep.; $0.75(OTS)
78492	18-13285	Dep.(mc); $1.60(fs), $0.80(mf) OTS
78658	18-12519	Dep.(mc); $1.60(fs), $0.80(mf) OTS
78788	18-12549	$2.60(fs), $1.10(mf) OTS
78878	18-12550	Dep.(mc); $1.10(fs), $0.80(mf) OTS
79296	18-11964	Dep.; $0.50(OTS)
79350	18-12035	Dep.; $0.75(OTS)
79621	18-12416	Dep.; $0.75(OTS)
79669	18-13286	Dep.; $1.00(OTS)
79810	18-12644	Dep.(mc); $1.10(fs), $0.80(mf) OTS
79845	18-12551	Dep.; $1.10(fs), $0.80(mf) OTS
79846	18-12645	Dep.; $1.60(fs), $0.80(mf) OTS
80750	18-12283	Dep.(mc); $1.10(fs), $0.80(mf) OTS
HW-SA–		

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3127	18-12725	Dep.(mc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-225-63
3223	18-12093	J. Phys. Chem., 68: 438-9(1964)
IA-	**(Non-AEC)**	
825	18-12008	Intern. J. Appl. Radiation Isotopes, 14: 623-4(1963)
856	18-13032	Dep.(mc)
864	18-12255	Dep.(mc)
906	18-12123	Dep.(mc)
IDA-HQ-	**(Non-AEC)**	
63-1345	18-12335	$1.60(OTS)
IDO-		
11006	18-12314	Dep.; $2.25(OTS)
11107	18-12141	See MITNE-39
11300	18-11628	Dep.(mc); $8.10(fs), $2.72(mf) OTS
14621	18-12256	Dep.; $1.00(OTS)
14624	18-13345	Dep.; $1.50(OTS)
28617	18-13287	Dep.; $1.50(OTS)
IFA-FT-	**(Rumanian)**	
50	18-12899	Dep.(mc)
INSJ-	**(Japanese)**	
65	18-12346	Dep.(mc)
IS-		
615	18-12764	Dep.; $1.50(OTS)
732	18-11982	Anal. Chem., 36: 532-6(1964)
ISS-	**(Italian)**	
63/39	18-13355	Dep.(mc)
JINR-	**(Russian)**	
E-1471	18-13044	Dep.(mc)
P-1443	18-12968	Dep.(mc)
P-1470	18-13045	Dep.(mc)
P-1472	18-13046	Dep.(mc)
P-1475	18-12417	Dep.(mc)
P-1476	18-12900	Dep.(mc)
P-1480	18-12801	Dep.(mc)
P-1481	18-12901	Dep.(mc)
P-1483	18-12969	Dep.(mc)
P-1487	18-12902	Dep.(mc)
P-1489	18-12460	Dep.(mc)
P-1490	18-12903	Dep.(mc)
P-1491	18-12904	Dep.(mc)
P-1493	18-12970	Dep.(mc)
P-1495	18-13047	Dep.(mc)
P-1497	18-12533	Dep.(mc)
P-1510	18-13048	Dep.(mc)
P-1513	18-12905	Dep.(mc)
JPRS-	**(Non-AEC)**	
23121	18-12603	$0.50(OTS)
23361	18-12045	$3.00(OTS)
JUL-	**(German)**	
110-HP	18-12906	Dep.(mc)
K-		
1400	18-11965	Dep.; $0.50(OTS)
KFK-	**(German)**	
177	18-13332	Dep.(mc)
K-T-		
552	18-12418	Dep.(mc); $3.60(fs), $1.34(mf) OTS

Report No.	Abstract No.	Availability
LA-		
2980	18-12765	Dep.; $1.75(OTS)
LADC-		
5935	18-12839	Phys. Rev., 133: A1537-45(1964)
LAMS-		
3022	18-12552	Dep.; $0.75(OTS)
3028	18-13356	Dep.; $1.25(OTS)
3036	18-13333	Dep.; $0.50(OTS)
M-	**(Misc.)**	
63-2	18-12338	See TID-20200
MCW-		
1482	18-12553	Dep.; $1.00(OTS)
MITNE-	**(Misc.)**	
39	18-12141	Dep.(mc); $26.00(fs), $16.25(mf) OTS
MLM-		
914	18-13049	Dep.; $0.50(OTS)
1148	18-13357	Dep.; $2.60(fs), $1.04(mf) OTS
1151	18-13358	Dep.; $2.60(fs), $1.04(mf) OTS
1182	18-12520	Dep.; $0.50(OTS)
MND-	**(Misc.)**	
2945-4	18-12858	
MR-	**(Non-AEC)**	
1190-50	18-12383	See AD-413416
MRC-	**(Misc.)**	
451	18-13359	Dep.(mc); $1.60(fs), $0.80(mf) OTS
MSAR-	**(Misc.)**	
64-14	18-12582	Dep.(mc); $3.60(fs), $1.34(mf) OTS
N-	**(Misc.)**	
63-14027	18-12995	See NASA-TN-D-1751
63-15259	18-12293	$10.10(fs), $3.89(mf) OTS
63-15501	18-13132	See NASA-TN-D-1783
63-17624	18-12994	
63-18164	18-12728	See RAI-308
63-20172	18-12720	See D2-90037-9
NAA-SR-Memo-		
8598	18-12649	Dep.(mc); $2.60(fs), $0.83(mf) OTS
8607	18-13238	Dep.(mc); $6.60(fs), $2.15(mf) OTS
8981	18-13248	Dep.(mc); $3.60(fs), $1.22(mf) OTS
9008	18-13249	Dep.(mc); $8.10(fs), $2.75(mf) OTS
9046	18-13288	Dep.(mc); $3.60(fs), $1.28(mf) OTS
9057	18-12598	Dep.(mc); $1.60(fs), $0.80(mf) OTS
9130	18-13250	Dep.(mc); $1.60(fs), $0.80(mf) OTS
9148	18-13251	Dep.(mc); $1.60(fs), $0.80(mf) OTS
9169	18-13252	Dep.(mc); $1.60(fs), $0.80(mf) OTS
9172	18-12315	Dep.(mc); $6.60(fs), $2.18(mf) OTS
9174	18-13050	Dep.(mc); $1.60(fs), $0.80(mf) OTS
9181	18-13360	Dep.(mc); $3.60(fs), $1.25(mf) OTS
9184	18-13253	Dep.(mc); $1.60(fs), $0.80(mf) OTS
9193	18-13254	Dep.(mc); $1.60(fs), $0.80(mf) OTS
9197	18-13188	Dep.(mc); $5.60(fs), $1.94(mf) OTS
9203	18-13316	Dep.(mc); $3.60(fs), $1.25(mf) OTS
9207	18-12846	Dep.(mc); $6.60(fs), $2.03(mf) OTS
9214	18-13051	Dep.(mc); $1.60(fs), $0.80(mf) OTS
9235	18-12368	Dep.(mc); $4.60(fs), $1.61(mf) OTS
9244	18-13289	Dep.(mc); $3.60(fs), $1.16(mf) OTS
9309	18-13361	Dep.(mc); $8.60(fs), $2.81(mf) OTS
9314	18-13052	Dep.(mc); $6.60(fs), $2.03(mf) OTS
9327	18-13176	Dep.(mc); $7.60(fs), $2.42(mf) OTS
9334	18-12650	Dep.(mc); $1.60(fs), $0.80(mf) OTS

Report No.	Abstract No.	Availability
9349	18-12847	Dep.(mc); $1.10(fs), $0.80(mf) OTS
NADC-MA-	**(Non-AEC)**	
6315	18-11629	
NARF-	**(Non-AEC)**	
62-16T	18-13177	
NASA-TM-	**(Non-AEC)**	
X-28	18-13317	
NASA-TN-	**(Misc.)**	
D-1185	18-12284	$1.25(OTS)
D-1725	18-13334	$2.00(OTS)
D-1751	18-12995	$0.50(OTS)
D-1783	18-13132	$0.50(OTS)
D-1944	18-12554	$1.00(OTS)
D-1985	18-12971	Dep.(mc); $0.75(OTS)
D-2098	18-12726	$0.75(OTS)
D-2118	18-13131	$1.25(OTS)
D-2124	18-13318	$0.75(OTS)
D-2170	18-13053	$1.25(OTS)
NBS-	**(Misc.)**	
8212	18-13133	Dep.(mc); $1.60(fs), $0.80(mf) OTS
NCSC-	**(Misc.)**	
2663-15	18-12651	Dep.(mc); $1.60(fs), $0.80(mf) OTS
NLCO-		
900	18-12599	Dep.; $1.50(OTS)
NOLC-	**(Non-AEC)**	
585	18-12036	$2.60(OTS)
NP-	**(AEC File No. for Non-AEC Reports)**	
13501	18-11968	
13516	18-12859	
13555	18-11558	
13560	18-13054	
13562	18-12419	
13566	18-12766	
13568	18-12385	Dep.(mc)
13572	18-11571	
13573	18-11572	
13574	18-11633	
13575	18-11634	
13576	18-11635	
13577	18-11636	
13578	18-11637	
13579	18-11638	
13580	18-11639	
13581	18-11640	
13582	18-11641	
13583	18-11642	
13584	18-11643	
13591	18-12860	
13592	18-13007	
13593	18-12652	
13594	18-12861	
13597	18-13335	Dep.(mc)
13599	18-12386	Dep.(mc)
13600	18-11644	
13602(Vol.I)	18-12907	
13602(Vol.II)	18-12908	
13615	18-12555	
13620	18-12257	
13622	18-12037	$1.00(GPO)
13627	18-12909	Dep.(mc)
13628	18-12600	OTS
13629	18-12556	OTS
NP-tr-	**(AEC File No. for Non-AEC Translations)**	
1090	18-12842	
1105	18-12564	Dep.(mc); $1.60(fs), $0.80(mf) JCL
NRC-	**(Canadian)**	
7737	18-12192	J. Chem. Phys., 40: 582-5(1964)
NRL-	**(Misc.)**	
5897	18-13055	$6.60(OTS)
NRL-Memo-	**(Misc.)**	
1481	18-13336	$2.60(OTS) as AD-430751
NYO-		
2907-1	18-13243	Dep.(mc); $1.60(fs), $0.80(mf) OTS
7988	18-12142	Dep.(mc); $4.60(fs), $1.58(mf) OTS
9650	18-12316	Dep.; $2.75(OTS)
10433	18-13362	Dep.(mc); $6.60(fs), $2.21(mf) OTS
10483	18-12147	See RRL-127
10702	18-12317	Dep.(mc); $10.10(fs), $3.95(mf) OTS
ORA-	**(Misc.)**	
03106-13-T	18-12797	See AD-412320
ORNL-		
3444	18-12802	Dep.; $0.75(OTS)
3544	18-12038	Dep.; $0.50(OTS)
3548	18-13363	Dep.; $0.50(OTS)
3549	18-13178	Dep.; $0.50(OTS)
3557	18-12653	Dep.; $0.75(OTS)
3564	18-13134	Dep.; $2.25(OTS)
3570	18-13179	Dep.; $0.75(OTS)
ORNL-TM-		
661	18-13337	Dep.(mc); $1.60(fs), $0.80(mf) OTS
710	18-13338	Dep.(mc); $1.60(fs), $0.80(mf) OTS
722	18-12557	Dep.(mc); $2.60(fs), $0.83(mf) OTS
739	18-12558	Dep.(mc); $5.60(fs), $1.85(mf) OTS
771	18-13056	Dep.(mc); $1.60(fs), $0.80(mf) OTS
786	18-12461	Dep.(mc); $1.10(fs), $0.80(mf) OTS
787	18-13290	Dep.(mc); $1.60(fs), $0.80(mf) OTS
788	18-13033	Dep.(mc); $1.10(fs), $0.80(mf) OTS
795	18-13057	Dep.(mc); $6.60(fs), $2.30(mf) OTS
ORO-		
614	18-11645	Dep.; $2.50(OTS)
OTS-	**(Misc.)**	
64-21508	18-12605	For translation see JPRS-23121
64-21632	18-12045	For translation see JPRS-23361
PA-TM-	**(Non-AEC)**	
1167	18-12124	
PA-TR-	**(Non-AEC)**	
3045	18-12727	
PAN-	**(Polish)**	
437/IA	18-12462	Dep.
442/I,I-A	18-12463	Dep.
443/I,IA	18-12464	Dep.
450/VII	18-12910	Dep.
451/VII	18-12911	Dep.
452/XIX	18-11969	Dep.
453/XIX	18-12258	Dep.
456/XVII	18-12143	Dep.
457/XVII	18-12144	Dep.
458/XVI	18-12522	Dep.
PATENTS	**(British)**	**3s. 6d. each, U. K. Patent Office**
945,621	18-12480	

Report No.	Abstract No.	Availability
947,074	18-12303	
947,104	18-13204	
947,217	18-13205	
947,281	18-12882	
947,327	18-12611	
947,509	18-12431	
947,533	18-12481	
947,558	18-12612	
947,564	18-13194	
947,592	18-13206	
947,712	18-12432	
947,715	18-13267	
947,775	18-13207	
947,850	18-12433	
947,878	18-12613	
947,892	18-12304	
947,893	18-13310	
948,003	18-12434	
948,168	18-13208	
948,233	18-13209	
948,310	18-12367	
948,313	18-13268	
948,316	18-13195	
948,371	18-12269	
948,479	18-13269	
948,659	18-12569	
948,733	18-12305	
948,762	18-12250	
948,791	18-12570	
948,890	18-13210	
948,909	18-13211	
948,948	18-12614	
948,973	18-13182	
949,013	18-13212	
949,020	18-13213	
949,048	18-12482	
949,102	18-12029	
949,103	18-13270	
949,107	18-12615	
949,117	18-13214	
949,162	18-13215	
949,191	18-12251	
949,232	18-12435	
949,236	18-13271	
949,458	18-13216	
949,459	18-13217	
949,483	18-12270	
949,577	18-12323	
949,608	18-12324	
949,727	18-12616	
949,743	18-13311	
949,778	18-12306	
949,780	18-13218	
949,826	18-12483	
949,832	18-12271	
949,931	18-12307	
949,951	18-12114	
950,163	18-12617	
950,198	18-12272	
950,200	18-12115	
PATENTS	**(German)**	
1,154,205	18-12484	
1,154,644	18-12618	
1,154,793	18-12529	
1,154,884	18-12406	
1,155,096	18-12530	
1,155,425	18-12531	
1,155,607	18-12571	
1,156,178	18-12485	
1,156,179	18-12116	
1,156,513	18-12486	
1,156,514	18-12487	
1,156,901	18-13272	
1,156,902	18-13219	
1,157,591	18-12273	
1,158,186	18-12488	
1,158,187	18-12489	
1,158,188	18-12490	
1,158,189	18-12491	
1,158,190	18-13220	
1,158,638	18-12492	
1,158,640	18-12274	
1,158,642	18-13221	
1,159,105	18-12619	
1,159,404	18-12572	
1,159,572	18-13273	
1,159,573	18-13222	
1,159,920	18-12275	
1,159,921	18-12276	
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3,119,686	18-12117	
3,119,687	18-12573	
3,119,744	18-13223	
3,119,745	18-12590	
3,119,746	18-13224	
3,119,747	18-13274	
3,119,933	18-12407	
3,120,471	18-13244	
3,120,475	18-13172	
3,120,478	18-12252	
3,120,607	18-12436	
3,120,609	18-12821	
3,120,610	18-12795	
3,120,612	18-12373	
3,120,613	18-12408	
3,120,621	18-12883	
3,121,041	18-11956	
3,121,048	18-12884	
3,121,146	18-13225	
3,121,164	18-12374	
3,121,166	18-12437	
3,121,168	18-12518	
3,121,199	18-12438	
3,121,789	18-12409	
3,121,794	18-13183	
3,121,816	18-12819	
3,122,485	18-12820	
3,122,631	18-12439	
3,122,635	18-12493	
3,122,636	18-12375	
3,122,640	18-12494	
3,122,643	18-12501	
3,122,663	18-12885	
3,122,702	18-12840	
3,123,165	18-12440	
3,123,328	18-13226	
3,123,435	18-12118	
3,123,436	18-12119	
3,123,511	18-12495	
3,123,532	18-13227	
3,123,533	18-13228	
3,123,535	18-13275	
3,123,576	18-13184	
3,123,700	18-12759	
3,123,708	18-12376	
3,123,709	18-12377	
3,123,713	18-12308	
3,123,862	18-12309	
3,124,172	18-12277	
3,124,513	18-13229	

Report No.	Abstract No.	Availability
3,124,514	18-13230	
3,124,538	18-12796	
3,124,625	18-12120	
3,125,409	18-12278	
3,125,492	18-13173	
3,125,678	18-12496	
3,125,760	18-13231	
3,126,251	18-12279	
PG-Report-	(British)	
464	18-11970	Dep.; $0.50(BIS); 2s. 6d. (HMSO)
502	18-12654	Dep.; $0.60(BIS); 3s. (HMSO)
526	18-11971	Dep.; $0.50(BIS); 2s. 6d. (HMSO)
532	18-11972	Dep.; $0.40(BIS); 2s. (HMSO)
540	18-11973	Dep.; $0.60(BIS); 3s. (HMSO)
550	18-12336	Dep.; $2.00(BIS); 10s. (HMSO)
552	18-11974	Dep.; $0.40(BIS); 2s. (HMSO)
PL-	(Finnish)	
86	18-12347	Dep.(nc)
PNE-		
226F	18-11567	Dep.; $0.50(OTS)
PRDC-TR-		
75	18-13291	Dep.(nc); $1.60(fs), $0.80(mf) OTS
PRMC-		
14	18-12145	Dep.(nc); $1.60(fs), $0.80(mf) OTS; Gmelin, AED-CONF-63-137-4
PWA-	(Non-AEC)	
1921	18-12039	
2303	18-12862	
R-	(Misc.)	
2174	18-12540	See EURAEC-493
RADC-TDR-	(Misc.)	
63-29	18-12465	$10.50(OTS)
63-135	18-13142	$8.10(OTS)
RAI-	(Misc.)	
308	18-12728	$10.10(fs), $4.10(mf) OTS
314	18-12146	
REIC-ACCESS-	(Non-AEC)	
71	18-12729	$2.60(OTS)
RHD-	(Non-AEC)	
Vol.IV, No.9	18-12398	$0.50(GPO)
Vol.V, No.1	18-12401	$0.50(GPO)
RM-	(Misc.)	
3575-PR	18-13180	$2.60(OTS)
RRL-		
127	18-12147	Dep.(nc); $1.60(fs), $0.80(mf) OTS
RTD-TDR-	(Non-AEC)	
63-1050	18-12996	$9.60(OTS)
63-4177	18-12828	
63-4244	18-12858	See MND-2945-4
RTD-TR-	(Non-AEC)	
8-112	18-12601	
SB-	(Non-AEC)	
62-46	18-12717	See AD-296358
63-55	18-12556	See NP-13629
63-56	18-12600	See NP-13628
SC-	(Misc.)	
4794(RR)	18-13364	Dep.; $2.50(OTS)
4976(RR)	18-13365	Dep.(nc); $2.60(fs), $1.04(mf) OTS
SCDC-		
3398	18-12081	See TID-19269
SC-DC-		
64-303	18-12655	Dep.(nc); $5.60(fs), $1.82(mf) OTS
64-326	18-13366	Dep.(nc); $2.60(fs), $0.86(mf) OTS
SC-DR-		
320-63	18-13367	Dep.(nc); $3.60(fs), $1.16(mf) OTS
SCL-TM-		
64-26	18-13372	Dep.(nc); $5.60(fs), $1.82(mf) OTS
SC-R-		
322	18-13368	Dep.; $1.50(OTS)
SC-TM-		
64-26	18-13369	Dep.(nc); $4.60(fs), $1.49(mf) OTS
352-63(24)	18-13370	Dep.(nc); $1.60(fs), $0.80(mf) OTS
354-63(72)	18-13371	Dep.(nc); $2.60(fs), $0.92(mf) OTS
SGAE-	(Austrian)	
1963/3B	18-12523	Dep.(nc)
SID-	(Non-AEC)	
63-656	18-12997	
SLAC-		
24	18-12420	Dep.; $0.50(OTS)
SM-	(Misc.)	
42/56	18-13236	See EIR-57
SRO-		
98	18-13292	Dep.(nc); $1.10(fs), $0.80(mf) OTS
SSD-TDR-	(Non-AEC)	
63-99	18-12040	$2.60(OTS)
63-204	18-12998	$3.60(OTS)
63-338	18-13143	$1.60(OTS)
STI-PUB-	(International Atomic Energy Agency)	
77(Vol.II)	18-12566	$11.00; Sch 231,-; 66s.stg; F.fr.44,-; DM 38.50(IAEA)
TDR-	(Non-AEC)	
169(3260)TN-5	18-12998	See SSD-TDR-63-204
TID-		
7681	18-12497	Dep.; $1.75(OTS)
7685	18-12803	Dep.(nc); $4.60(fs), $1.64(mf) OTS
7686	18-12804	Dep.(nc); $10.10(fs), $4.07(mf) OTS
13635	18-11646	Dep.(nc); $5.60(fs), $1.73(mf) OTS
18022	18-12352	Limnol. Oceanog., 9: 1-11(1964)
18285	18-11647	Dep.; $1.00(OTS)
19245	18-12772	J. Appl. Phys., 35: 512-15(1964)
19269	18-12081	J. Chem. Phys., 40: 1168-9(1964)
19445	18-13107	Phys. Rev., 133: B1178-82(1964)
19489	18-12041	Dep.; $1.25(OTS)
19562	18-11568	Dep.; $1.25(OTS)
19941	18-13346	Dep.(nc); $8.60(fs), $3.14(mf) OTS
19969	18-11648	Dep.; $2.00(OTS)
19977	18-11559	Dep.(nc); $11.00(fs), $4.61(mf) OTS
20031	18-11649	Dep.(nc); $1.10(fs), $0.80(mf) OTS
20067	18-12148	Dep.(nc); $8.60(fs), $3.02(mf) OTS
20072	18-12149	Dep.(nc); $5.60(fs), $1.76(mf) OTS

Report No.	Abstract No.	Availability
20083	18-12337	Dep.(mc); $8.10(fs), $2.84(mf) OTS
20106	18-11573	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20108	18-11650	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20112	18-12916	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20113	18-12972	Dep.(mc); $2.60(fs), $0.83(mf) OTS
20114	18-12042	Dep.(mc); $1.10(fs), $0.80(mf) OTS
20121	18-11651	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20122	18-11652	Dep.(mc); $5.60(fs), $1.85(mf) OTS
20123	18-12125	Dep.(mc); $1.10(fs), $0.80(mf) OTS
20124	18-12150	Dep.(mc); $1.10(fs), $0.80(mf) OTS
20131	18-13293	Dep.(mc); $10.10(fs), $3.95(mf) OTS
20137	18-13144	Dep.(mc); $1.10(fs), $0.80(mf) OTS
20141	18-13294	Dep.(mc); $1.10(fs), $0.80(mf) OTS
20143	18-13295	Dep.(mc); $1.10(fs), $0.80(mf) OTS
20146	18-13296	Dep.(mc); $1.10(fs), $0.80(mf) OTS
20147	18-12043	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20150	18-12559	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20155	18-13373	Dep.(mc); $11.50(fs), $1.73(mf) OTS
20160	18-13374	Dep.(mc); $8.60(fs), $3.20(mf) OTS
20168	18-11959	Dep.(mc); $3.60(fs), $1.31(mf) OTS
20169	18-12829	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20172	18-13375	Dep.(mc); $2.60(fs), $0.92(mf) OTS
20174	18-12044	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20175	18-13376	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20177	18-13297	Dep.(mc); $4.60(fs), $1.61(mf) OTS
20178	18-13298	Dep.(mc); $8.10(fs), $2.78(mf) OTS
20179	18-13299	Dep.(mc); $1.10(fs), $0.80(mf) OTS
20180	18-13300	Dep.(mc); $1.10(fs), $0.80(mf) OTS
20184	18-13377	Dep.(mc); $1.10(fs), $0.80(mf) OTS
20186	18-13378	Dep.(mc); $1.60(fs), $0.80(mf) OTS
20189	18-13379	Dep.(mc); $4.60(fs), $1.70(mf) OTS
20192	18-12151	Dep.(mc); $2.60(fs), $0.98(mf) OTS
20197	18-12767	Dep.(mc); $1.60(fs), $0.80(mf) OTS
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